JANUARY 1956

Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

FIVE DOLLARS A YEAR

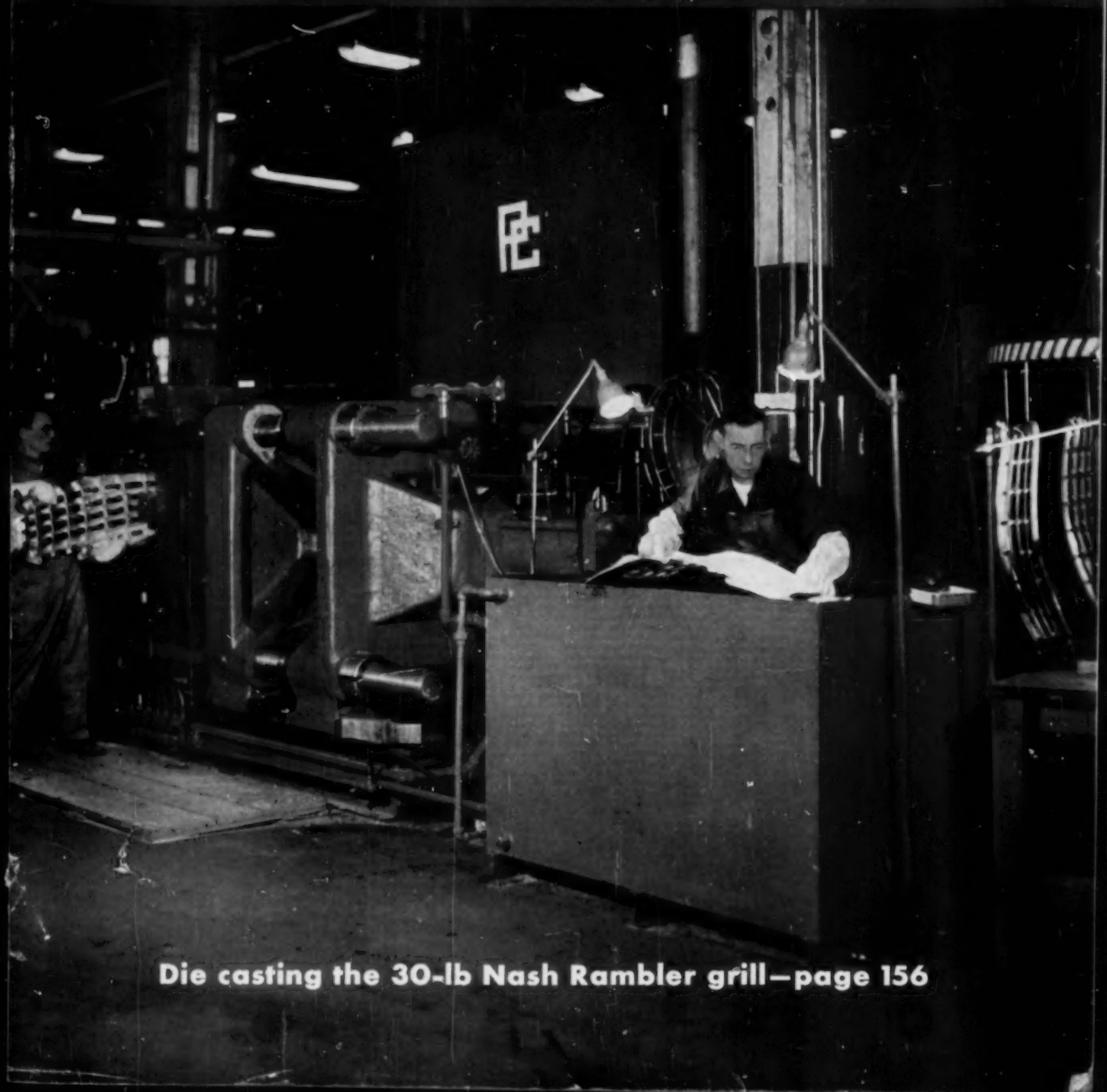
Germany's Boom

built on education, engineering, energy

Solid-Film Lubricants

High Temperature Seals

Corrosion by Cavitation



Die casting the 30-lb Nash Rambler grill—page 156

WHEN YOU DEMAND CRITICAL PRECISION

Only one part . . . the spool . . . moves in this ingenious MAC 4-way air valve. It's an oscillation that must be critically precise . . . and is. The C/R Sirvene (synthetic rubber) parts seal the valve circuits under pressures up to 150 psi and over a wide range of temperatures and cycle speeds. To operate correctly, those small Sirvene parts must be molded to unusually close dimensional tolerances. C/R is consistently meeting . . . and beating these tolerances. And MAC reports that on the toughest jobs their valves have run for millions of cycles without trouble.

You can have the same dependability. Whenever your mechanism design demands the most exacting qualities in a molded pliable part . . . depend on Sirvene. As a start—write for your copy of the new "Sirvene" booklet.

SIRVENE C/R DIVISION

CHICAGO RAWHIDE

CHICAGO RAWHIDE MANUFACTURING COMPANY

1301 Elston Avenue, Chicago 22, Illinois

Offices in 55 principal cities • See your telephone book

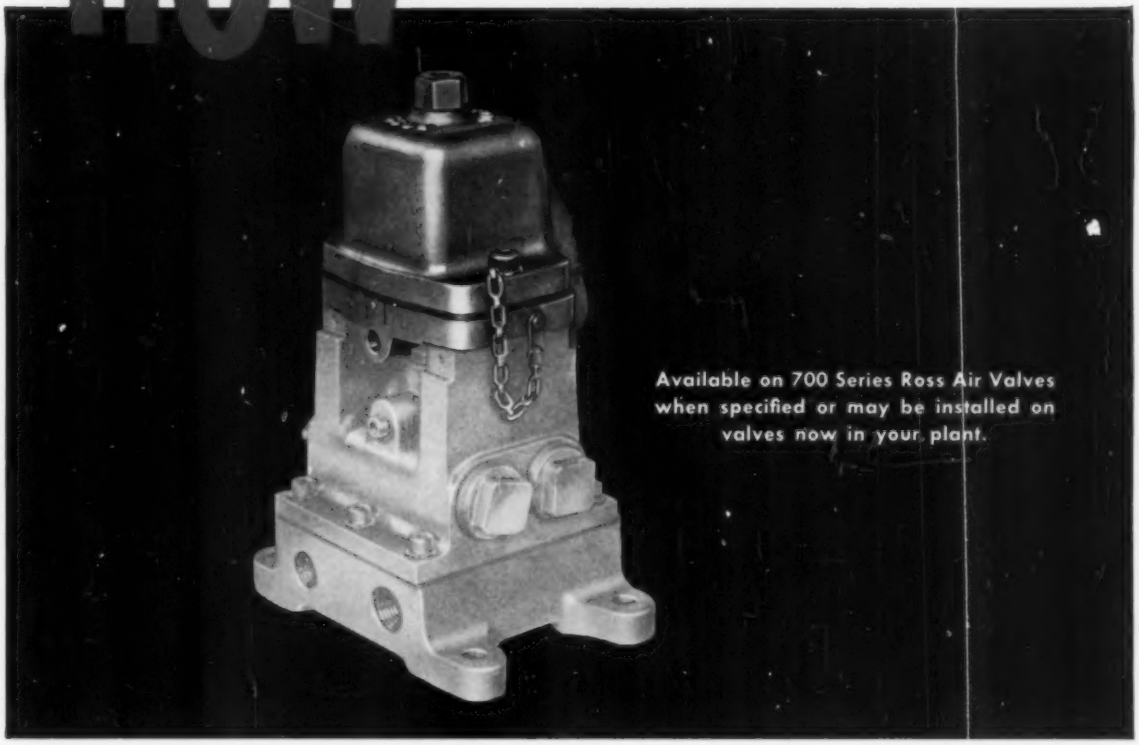
In Canada: Manufactured and Distributed by Super Oil Seal Mfg. Co., Ltd., Hamilton, Ontario

Export Sales: Geon International Corp. Great Neck, New York.

Other C/R Products

C/R Shaft and End Face Seals • Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-metallic Gears

new JIC Solenoid and Cover!



Available on 700 Series Ross Air Valves when specified or may be installed on valves now in your plant.

- Cover protects solenoid against dust, splashing liquids and airborne contaminations.
- Can be manually operated without removing cover.
- Ample wiring connection space.
- Ring type pressure connectors.
- Interchangeable with standard Ross cover and solenoid.
- Valve becomes electrically inoperative when cover is removed.
- Captive type cover fasteners.
- Chain to prevent loss of cover.
- Threaded electrical conduit connection.
- Provision for piped exhaust.

- JIC Solenoid Cover and Head Assembly also available for 700 Series Momentary Valves.

Tomorrow's Engin*AI*Ring Delivered Today . . . Anywhere

ROSS Control VALVES

Ross OPERATING VALVE COMPANY

114 E. GOLDEN GATE AVENUE • DETROIT 3 • MICHIGAN

G-E Type AK-1-50 Electrically Operated Air Circuit Breaker, 1600-amperes, 600 Volts, A-C. One pole shown. Made by General Electric Company, Low Voltage Switchgear Department, 6901 Elmwood Ave., Philadelphia, Pa.

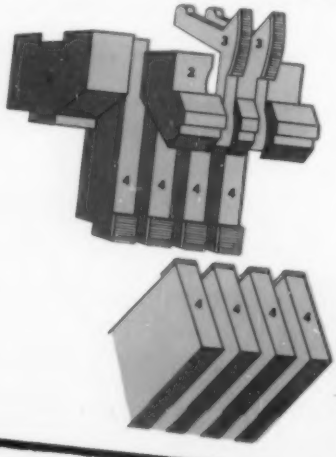
USE REVERE EXTRUDED SHAPES *they Save Money!*

Here is the General Electric Type AK-1-50 Electrically Operated Air Circuit Breaker, 1600-ampere frame size used to protect low-voltage systems. The picture shows one pole of the contact, and in order to photograph it, the housing and the arc-quencher parts were removed. Note the Revere Extruded Shapes, and Rectangular Rod. There are three shapes, and one size of bar, all in copper, because copper has the highest electrical conductivity of all commercial metals.

If these shapes had to be "hogged" out of bar, they would be expensive, due to the machining time, and the scrap generated. While copper scrap is readily salable at good prices, it is costly from the machining standpoint. Extruded shapes by Revere, preformed to the desired contours, usually reduce machining to a cutting-off operation, plus such minor details as drilling which cannot be done during extrusion. Shapes naturally cost more per pound than bar or rod, but the ultimate saving makes up for the difference and more, sometimes several times.

Are you doing much machining of copper? If so, look into Revere Extruded Shapes. They may save money, and speed up production as well. See the nearest Revere Sales Office.

Sketch showing details of contacts. Nos. 1, 2 and 3 are extruded and drawn copper shapes. No. 4 is rectangular copper bar. Cross hatching represents special arcing contacts brazed to the copper.



REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y. —Sales Offices in Principal Cities, Distributors Everywhere

Product Engineering

JANUARY 1956 Vol. 27 No. 1 The McGraw-Hill Magazine of Design Engineering

Germany's Amazing Comeback ..... George F. Nordenholt 135
How national recognition and application of the powers of education, engineering and energy are speeding the nation to rapid recovery, and then some. First-hand study of this phenomenal rebirth based on a two-month's trip abroad by the Editor of Product Engineering.

High Temperature Seals ..... T. J. McCuistion 151
Factors affecting design of glands for sealing reciprocating or rotary motion under extremes of heat and pressure; seal material, gland design, lubrication and surface.

Redesign for Die Castings ..... J. J. Punke 156
Design tips on reducing piece cost: built-in fastenings; use of inserts and rib design to save metal; cored holes, fillets, corners, draft and undercuts; and tolerances.

Product Designs 160
Magnesium castings in the Volkswagen; no-play mechanism for camera stand; constant-velocity universal joint in engine tester; hydraulic engine starter; all-electric surface grinder with pressure lubrication; 16-stage assembly machine designed for fast re-tooling; illuminated control dial for appliances.

Pneumatic Time Delay Relays ..... Carl Lindahl 174
How pneumatic time-delay relays operate; performance, contact arrangements and applications.

Plate Cam Design—Evaluating Dynamic Loads ..... M. Kloomok and R. V. Muffley 178
Fourth article in this series evaluates effect of weight and frictional drag of moving parts, spring loads and pressure angles on cams with radial and swinging followers.

Estimating Government Contracts ..... M. J. Phillips 183
Precise procedure with forms for estimating material, labor, tooling and overhead.

Minimum Inertia in Geared Drives ..... Martin A. Baer 186
Dynamic analysis of a hoist drive develops equations useful wherever heavy starting loads are met.

Electrohydraulics in Machine Tools ..... A. Durr 188
Concluding article shows how "electrohydraulic" design thinking is applied to: production milling machine, large planer-miller, automatic lathe, crankshaft lathe.

Mechanical Corrosion ..... Russell W. Henke 194
Causes of stress corrosion, corrosion fatigue, impingement, erosion and fretting; guides in selection of most resistant material, and influence of design factors.

Fractional Horsepower Motors ..... Sidney Davis 198
Selection chart, schematic diagrams, speed-torque curves; applications for 12 types.

Strain-Gage Bridge Sensitivity Control ..... Peter K. Stein 200
How to apply an adjustable resistance in series with bridge voltage supply to simplify calibration and correct for system errors.

Mass Moments of Inertia ..... M. Kloomok and R. V. Muffley 215
Nomograms for calculating moments of inertia for cross sections of any shape in any material.

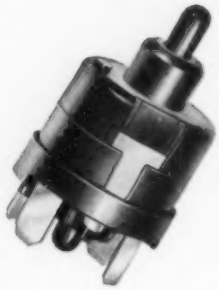
Oscillatory Accelerations ..... Joseph F. Sodaro 221
Alignment chart to determine acceleration in g's of a vibrating body.

DEVELOPMENTS TO WATCH . . . 5
DESIGN PERSPECTIVES 129
EDITORIALS 133, 212
TECHNICAL NEWS 205
COMING EVENTS 211
NEW COMPONENTS AND MATERIALS . . . 224
CATALOGS AND BULLETINS 309
SANS, SOUCI 326
ENGINEERING ABSTRACTS . . 329
NEW BOOKS 361
READERS' LETTERS 397
PRESS PREVIEWS 403

Number of copies printed this issue 36,258

MALLORY

Three different switching positions . . . actuating one or two circuits . . . are made in only ¼" of plunger travel. Help your cost reduction program by using the new plunger switch, shown here in actual size.



Try this Mallory Plunger Switch in Your New Product Designs

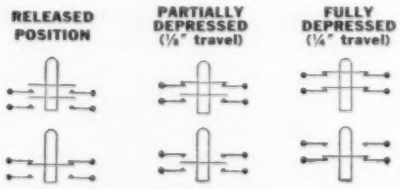
NEED something unusual in circuit switching for your product? Take a look at this Mallory plunger switch. Compact in size and modest in price, it can be actuated by a knob, door, cam or any of a score of similar devices. Several switches can be grouped for simultaneous or sequence switching by a rotary cam. You can use it as a limit switch, with or without "dead travel" . . . as SPDT . . . or as DPST.

Plunger travel is ¼". In this short space, you can have three different switching arrangements of the controlled circuits . . . in the released, partially released and fully depressed positions. It is possible, for example, to have two circuits opened or closed in sequence. Numerous other sequences are possible. Spring pressure can be supplied for many values over a considerable range.

Capacity of the switch is 15 amperes, 230 volts AC; 20 amperes, 115 volts; ¾ H.P. @ 115 volts; 1½ H.P. @ 230 volts. Supplied with ¼" wide x 1/32" thick spade terminals. Mounting requires only a single hole, using a spring grip washer . . . takes only seconds. Outside diameter is only 1 1/32". For complete data and prices, write or call Mallory today.

Many Switching Combinations Possible

Two of the many sequences possible with the Mallory plunger switch are diagrammed here. The upper series shows two circuits opened and closed in sequence as the plunger is depressed to full travel and released. In the lower series, a normally closed circuit is opened and a second circuit closed as the plunger is depressed. There is no stop at the intermediate position. The spring returns the plunger to the released position.



Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

Expect more . . . get more from

P. R. MALLORY & CO. Inc.
MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Solid Film Lubricants
High Temperature Seals
Corrosion by Cavitation
Die casting the 30-lb Nash Rambler grill—page 156

THIS MONTH'S COVER

Radiator grill for the Nash Rambler—a 30-lb zinc die casting—produced at the Fayetteville plant of Precision Castings Co. J. J. Punke, vice-president in charge of engineering, presents a detailed discussion of design factors involved in redesigning for die casting, starting on page 156 in this issue.

THE STAFF

Editor **G. F. NORDENHOLT**
Assistant to the Editor JOSEPH KERR
Managing Editor ROBERT W. CARSON

Associate Editors
RANDOLPH P. DOMINIC • HENRY E. COOK, JR.
RICHARD M. KOFF • JAMES R. McDERMOTT

Assistant Editors ROBERT E. ABBOTT
PAUL N. ANDERSON • NICHOLAS CHIRONIS
JOHN KOLB • RICHARD A. LAWRENCE
NORMA J. VAN NESS

Editorial Assistant LILLIAN F. WITHAM
Consulting Editor ROBERT E. BRUCKNER
Washington GEORGE B. BRYANT, JR.

Publisher **ALBERT HAUPTLI**
Advertising Sales Manager STANLEY J. ALLING
Manager, Market Research HUGH BRITTON
Reader Service Manager C. C. KANE
Business Manager RUSSELL T. DOUGLAS

Foreign News Bureau: LONDON • PARIS • BONN • RIO DE JANIERO • MEXICO CITY • TOKYO • BOMBAY

Product Engineering
A McGRAW-HILL PUBLICATION

JANUARY, 1956 **Vol. 27, No. 1**

Published monthly, with an additional issue in Mid-October, by the McGraw-Hill Publishing Co., Inc., Executive, Editorial, Advertising and Subscription offices **McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y.** Publication office, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Paul Montgomery, Executive Vice President; Joseph A. Gerardi, Vice President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice-President, Publications Division; Ralph B. Smith, Vice President, Editorial Director; Joseph H. Allen, Vice President and Director of Advertising; J. E. Blackburn, Jr., Vice President and Circulation Director.

FOR SUBSCRIPTIONS, write to: Subscription Service, 330 West 42nd Street, New York 36, N. Y. Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. **Orders must indicate company and position.** Allow one month for change in address.

Single copies 50¢. United States and possessions, $5 for one year, $8 for two years, $10 for three years; Canada, $6 for one year, $9 for two years, $12 for three years; other Western Hemisphere and the Philippines, $15 for one year, $25 for two years, $30 for three years; all other countries, $25 for one year, $40 for two years, $50 for three years. Second class mail provisions authorized at Albany, N. Y. U. S. A.

Copyright 1956 by McGraw-Hill Publishing Co., Inc.—All rights reserved.

Developments

To Watch

SUBSTITUTE HIGH TEMPERATURE ALLOYS . . . .

. . . . for jet engine use have been developed at Cornell Aeronautical Labs., Buffalo, N. Y. to replace strategic alloys such as nickel, cobalt, columbium and other metals in case of a stepped-up engine production. Improvements in hot strength of chromium-nickel stainless steels were achieved mainly with titanium and boron compositions, plus high temperature solution treatments in the range of 2100 to 2300 F. As a result, three titanium and titanium-boron chromium-nickel stainless steels were picked from about 150 experimental compositions and will undergo further investigation. These are: (1) 18 Cr-9 Ni-0.15 C-0.75 Ti stainless; (2) 17 Cr-12 Ni- 2.5 Mo-0.15 C-0.85 Ti stainless; (3) 17 Cr-12 Ni-2.5 Mo-0.15 C-0.15 B-0.85 Ti stainless. The tests also showed that there was no increase in strength with titanium contents greater than one per cent. Also, there was a decrease in the 1350 F and 1500 F rupture strength of the 18 Cr-9 Ni and the 17 Cr-12 Ni-2.5 Mo stainless steels after solution treating at temperatures above 2000 F. Boron contents above 0.2 per cent did not increase the high temperature strength of the Cr-Ni stainless steels. Stress-rupture properties were good for all three compositions. Good results were obtained with the 17 Cr-12 Ni-2.5 Mo-0.15 C-0.15 B steels with titanium or titanium and tungsten, after hot rolling to sheet at 1800 to 2000 F, and final solution treatment at 2300 F. Rupture strength for 100 hr at 1500 F was 18,500 psi, with ductilities of 8 to 9 per cent elongation.

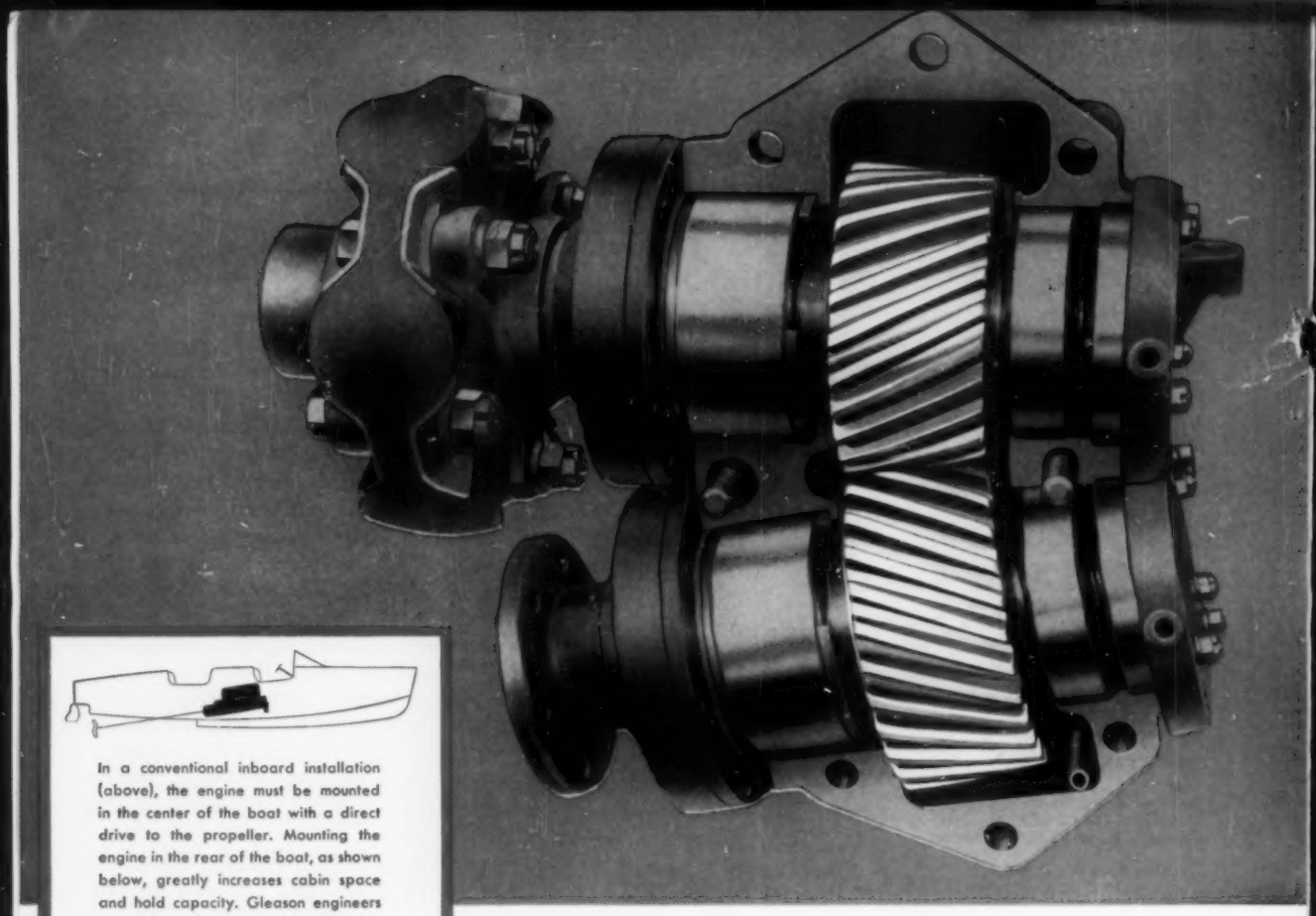
BEARINGS FOR 600 F WATER LUBRICATION . . .

. . . . are made of carbon granules mixed with a cobalt base alloy. From 60–70 per cent carbon by volume is used, with the metal skeleton supporting the mechanically weak carbon. Developed at the Armour Research Foundation of the Illinois Institute of Technology, Chicago 16, Ill., the bearing requires carbon granules of 100 mesh. The carbon granules interrupt any seizure of the bearing by the metal. A surface preparation for the bearing is necessary to prevent this metal wipeover and to sustain a liquid for lubrication. Bearing was designed for use in atomic reactors.

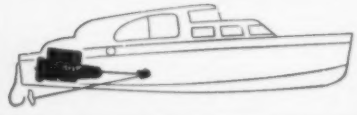
THE EFFECT OF RESIDUAL STRESS . . . .

. . . . on the strength of steel, plus an investigation of the various methods used for measuring residual stress, is a project now under way at the University of Illinois, Dept. of Theoretical and Applied Mechanics, Urbana, Ill. Because of the variety of ways used for measurement (strain gage; optical methods; curvative gage after removing layers of materials; and boring out of cylindrical sections), a comparison of results will be made of each. Identical parts will be made and sent to various companies for measuring by the different techniques.

(*continued on page 7*)



In a conventional inboard installation (above), the engine must be mounted in the center of the boat with a direct drive to the propeller. Mounting the engine in the rear of the boat, as shown below, greatly increases cabin space and hold capacity. Gleason engineers assisted the Marine Engine Manufacturers in the development of the V-Drive.



Angular power transmission can improve *your* product, too

Take, for example, this marine V-Drive. The use of spiral bevel gears permitted a design which released more usable space in the boat, improved balance, and simplified installation.

This is just one instance of the added flexibility of product design possible with angular power transmission.

Faster production and lower costs will also result from using this type of transmission.

If you have a design application for bevel or hypoid gears, the Gear Engineering Department of the Gleason Works is ready to help you realize every advantage possible. Design and production recommendations for your angular drive are offered at no obligation.

If you would like to discuss your bevel gear application with a Gleason representative, please contact us.

These Gleason Technical Handbooks are available on request:

Spiral Bevel Gear System
20° Straight Bevel Gear System
Zerol® Bevel Gear System

GLEASON WORKS

Builders of bevel gear machinery for over 90 years

1000 UNIVERSITY AVE., ROCHESTER 3, N.Y.

Developments to Watch

PNEUMATIC CONTROLS FOR HIGH TEMPERATURE USE . . . .

. . . . should eliminate one of the problems connected with high speed aircraft, according to Solar Aircraft Co., 2200 Pacific Highway, San Diego 12, Calif. Aircraft now in the development stage have been designed to fly at three times the speed of sound and hit the thermal barrier. Engine control devices at this speed will reach temperatures at 1000 F. Solar's pneumatic controls, using its Microjet principle, have been used in jet engines for afterburner light-off and blow-out detection, turbine inlet temperature control, overspeed control, and afterburner fuel control.

AN AUTOMOBILE WITH THREE DIFFERENTIALS . . . .

. . . . and full four wheel drive is reported to be the British answer to its falling automobile export market. Designer is tractor-maker, Harry Ferguson, who several years ago collected $9.25 million from Ford Motor Co. for infringement of his tractor patents. Still in the drawing board stage, the new system drives the front and rear wheels through three differentials which discriminate between the action needed when going around corners or when one or two of the wheels skid or spin. Diagramatically, there is a differential between the two rear wheels, another between the two front wheels, and a third between the main front and rear driving shafts. To compensate for spinning on ice, these differentials are limited in their action by calibrated free-wheeling elements which distribute driving torque and braking according to the road needs of each of the four wheels. (A similar system is used in some earthmoving machinery.) The brakes are disks fitted to the central differential rather than the wheels. In this way the braking force is transmitted as needed through the axle differentials. The engine is reported to be a flat, four-cylinder, air-cooled unit placed in the middle of the car. Transmission is fully automatic.

EFFECT OF SURFACE-FINISHING ON FATIGUE STRENGTH . . . .

. . . . of titanium alloys, in tests conducted at The Fatigue of Metals Lab., of the University of Illinois, Urbana, Ill., showed that there is a correlation between the indentation hardness of the test surface and its fatigue strength. In rough machining, surface cold-rolling, and grinding, it was found that the roughness of the surface influenced fatigue strength, but the effect did not appear to be as important as that of hardness. The relationship between the three may be expressed as: $Z = 207\ X^{-(0.0284)}\ Y^{(1.017)}$ where Z = the fatigue limit, psi; X = rms surface hardness, microin.; and Y = Knoop surface hardness (100 gram load). This shows that surface roughness does not seriously influence fatigue strength of these alloys. The fatigue limit falls off gradually at a decreasing rate with increasing roughness. Also, for constant values of surface roughness the relationship between fatigue limit and surface hardness is about linear.

THE USE OF PRECIOUS METALS FOR PLATING . . . .

. . . . is on the increase, particularly in industrial applications, and is offering an economical solution to materials problems. According to Harper-Leader, Inc., Waterbury, Conn., at temperatures like those found in jet engines, nuts and bolts tend to seize after several hours operation making disassembly difficult.

(*Continued on page 9*)

Maximum Rust Protection

and a fine black finish for iron and steel

This long-wearing, rust resistant product is used on many types of iron and steel articles: Nuts and bolts, brackets, screws, nails, springs; tools, casters, padlocks, machine housings and castings; outdoor furniture, hinges, latches, ornamental iron.

Parco Compound is a versatile metal treatment. It is simple to operate, easy to control, dependable and uniform in results, and economical. It creates a dense coating of nonmetallic phosphate crystals over the whole surface of the article treated. There are no limitations on size or shape—any article which can be immersed in the tank can have this protection. Oil, wax, stain, or paint finishes may be used over Parco Compound, to produce maximum rust resistance with deep, velvet black appearance.

Since 1915—leader in the field

Write for complete information!

*Bonderite, Bonderlube, Parco, Parco Lubrite, Parker Pre-Namel—Reg. U. S. Pat. Off.

PARKER

RUST PROOF COMPANY

2179 *East Milwaukee, Detroit 11, Michigan*

PARCO COMPOUND — rust resistant

PARCO LUBRITE — wear resistant for friction surfaces

BONDERITE — corrosion resistant paint base

BONDERITE and BONDERLUBE — aids in cold forming of metals

TROPICAL — heavy duty maintenance paints since 1883

A silver plate of 0.0001 to 0.0003 in. thickness will prevent such seizure. Thin coatings on bearing surfaces will increase the fatigue life. In microwave plumbing, the parts are usually made from brass or copper, then plated with silver to give the desired surface transmission, and finally with gold or rhodium over the silver to prevent tarnishing.

NEW PIEZOELECTRIC CERAMICS WITH GOOD STABILITY . . . .

. . . . over a wide temperature range are expected to replace barium titanate in many commercial uses in addition to extending the use of ceramic transducers. Just announced by The National Bureau of Standards, Washington 25, D. C., the ceramics are lead oxide based compositions having better electromechanical properties than the presently used barium titanate ceramics. In addition, they have a greater temperature range than barium titanate, which is 20 to 100 C. NBS states that one of the compositions—containing 45 per cent lead-titanate and 55 per cent lead-zirconate has a Curie point of 340 C, compared to 120 C for barium titanate. Lead titanate-lead zirconate has a radial coupling coefficient of greater than 0.3 at 275 C, and a voltage coefficient more than twice that of commercial barium-titanate.

TITANIUM IS BEING EXTRUDED . . . .

. . . . at Battelle Memorial Institute, Columbus, Ohio, in a project sponsored by the Wright Air Development Center. In order to further the application of titanium in aircraft applications, basic data in die designs, materials, and lubricants. To date the unalloyed titanium and the titanium 3 Mn complex have been extruded on an 850 ton press at speeds up to 41 in. per minute. One inch diameter bars have been extruded with an extrusion ratio of 21:1, or a reduction in area of 95.4 per cent. The extrusion press is preheated to 800 F while the dies are preheated to 500—800 F. Unalloyed titanium has been extruded at temperatures of from 1450 to 1900 F. In general, the tensile properties decrease with increased extrusion temperatures. With the titanium 3 Mn complex, the tensile and yield strengths are not affected by variation in extrusion temperatures within 1350 to 1700 F, but elongation and reduction of area are lower at higher temperatures.

AND IN ADDITION . . . .

. . . . Prediction from Detroit automotive engineers is that air conditioning units for automobiles will have a top price of $100 in about three years, as a result of more compact units and volume production; present prices are around $350–$400 . . . . A pocket-size telephone amplifier, made by Remler Co., 2101 Bryant St., San Francisco, Calif., clips on a phone and is easily transferred from one phone to another; equipped with a volume control, it increases acoustic output 3½ times for 120 hr steady operation on two batteries and three transistors . . . . Pilots of B-52 jet bombers are getting quick-reference thrust measuring instruments to increase efficiency of long-range flights, and add safety during take-offs; made by Minneapolis-Honeywell Regulator Co., and AiResearch Mfg. Co., the instruments measure and indicate the ratio engine turbine exhaust total pressure to engine inlet total pressure . . . . Two new types of rectifiers have been announced by Union Switch & Signal, Swissvale, Pa.; one based on a new copper alloy permits smaller units greater efficiency and regulation; and the other a small disk-type tubular rectifier featuring low cost.

Stainless castings show up to 190,000 psi strength after 875 F hardening treatment

Foundries report ultimate tensile strength as high as 190,000 psi in investment castings of Armco 17-4 PH Stainless Steel. This precipitation-hardening grade is easy to cast. It fills thin sections and details nicely, surface finish is good and tolerances small.

READILY MACHINABLE Armco 17-4 PH investment castings machine readily to an excellent surface finish. The subsequent 1-hour hardening treatment at 875 degrees F will not distort the part nor damage the surface. It causes only a slight discoloration.

NUMEROUS SUPPLIERS Armco does not make castings. If you are interested in high-strength, low-temperature hardening castings with high corrosion resistance, just fill out the coupon. We'll send you a list of suppliers of investment castings and other types made of Armco 17-4 PH Stainless Steel.

Armco Steel Corporation 1345 Curtis Street, Middletown, Ohio
Send me a list of producers of castings of Armco 17-4 PH Stainless Steel.

Name:_____

Firm:_____

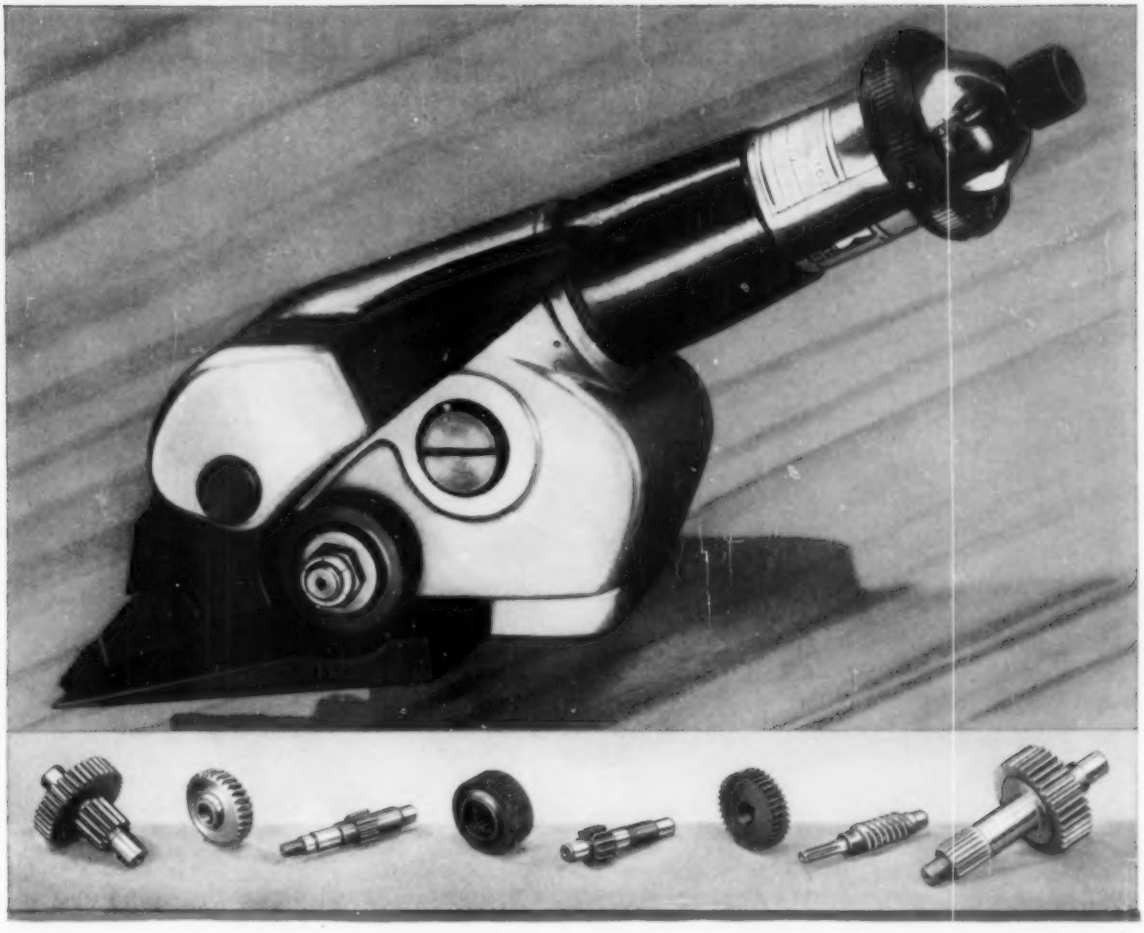
Street:_____

City:_____ Zone:_____ State:_____

ARMCO STEEL CORPORATION 1345 CURTIS STREET, MIDDLETOWN, OHIO

SPECIAL STEELS

SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • ARMCO INTERNATIONAL CORPORATION



G. S. Gearing Takes Terrific Punishment in the ACME Steelstrap Stretcher

ACME STEEL COMPANY specifies G. S. Gearing for the ACME Steelstrap Stretcher. Only Gearing of extreme accuracy and fine quality . . like G. S. Gearing . . can stand up under the gruelling service this sturdy Stretcher gives.

Critical customers from coast-to-coast have learned, through the years, to depend upon us *implicitly* for TOP quality Gearing in each succeeding shipment. Forty years of specializing . . of developing and perfecting men, methods and machines . . has resulted in our mass producing Small Gearing to a degree of UNIFORM accuracy *unapproached in the history of the industry!*

If decidedly better, *more uniformly accurate* Gearing is an important consideration in *your* business, by all means write or call us NOW! Let our capable engineers help you . . preferably while the job is on the boards. Suggestions, ideas, and cost estimates do not obligate you.

SEND FOR . . *our 6-page Small Gearing Guide. It illustrates and describes over 80 different types and applications of G. S. Small Gears, from 8 to 96 dp. Ask for it on company letterhead, please.*

40 Years of Specializing in Small Gearing!

FRACTIONAL HORSEPOWER GEARS

GS

GEAR Specialties, Inc.

Spurs · Spirals · Helicals · Bevels · Internals · Worm Gearing · Racks · Thread Grinding

2635 WEST MEDILL AVENUE · CHICAGO 47, ILLINOIS

MEMBER OF

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

Rubber in the right hands

can do wonders!

AVAIL YOURSELF OF THE SKILL, ENGINEERING ADVICE, SPECIAL COMPOUNDS AND PRECISION MOLDING OF UNITED STATES RUBBER COMPANY.

- ★ **A maker of milking inflations picked "U. S." molded rubber—because of its flexing characteristics (up to 400 hours in a flexing cycle test—where normal requirement is a 100 hour test.)**
- ★ **A utility company selected "U. S." molded rubber cable joints because "U. S." could fabricate an entirely *uniform* wall thickness in an extremely complex design. The high dielectric resistant compound provides top safety.**
- ★ **A lawn mower manufacturer cut labor time of treading from 7 minutes to 49 seconds—just by specifying "U. S." molded-drive roller rubbers.**

These are only a few of the hundreds of applications wherein U. S. Rubber's molded rubber works wonders. In the hands of "U. S." technicians, molded rubber becomes a basic material that will *do jobs no other material can do*. "U. S." research stockpiles, nationwide facilities and laboratories are joined with "U. S." experts in tackling any molded rubber goods problem quickly—and from every angle. Let "U. S." show you what it can do with molded rubber.

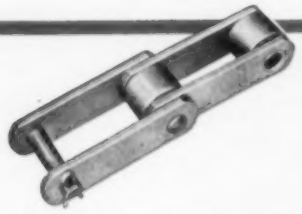
Get in touch with United States Rubber Company at Rockefeller Center, New York 20, New York.

US RUBBER

Mechanical Goods Division

United States Rubber

For longer chain life, here's
less bushing and joint wear



Large-diameter rollers of Link-Belt SS chains reduce chain-pull due to frictional resistance.

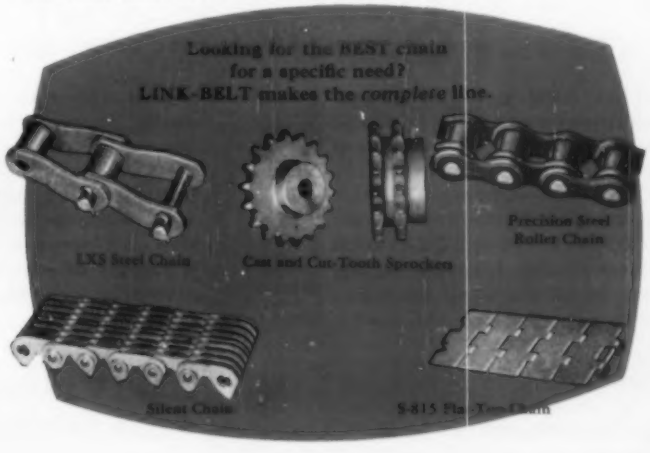
Link-Belt Class SS roller chain assures steady, even flow of fabricated products from medium-temperature industrial oven manufactured by The W. W. Sly Manufacturing Co., Cleveland, Ohio. Link-Belt precision steel roller chain and roller bearing blocks are also used.

LINK-BELT SS roller chains are designed for abrasive, heavy-duty service

For hard-working drives and conveyors, choose Link-Belt SS bushed roller chain. Its hardened steel joint assures longer life in gritty and abrasive applications. Accurately machined parts provide a firm, tight fit of pins and bushings in the steel sidebars. In addition, accurate control of raw material specifications and manufacturing processes results in uniformity . . . longer life.

Whatever your particular chain requirements in regard to speed, weight of loads or severity of service—the completeness of the Link-Belt line will provide the right answer. No other manufacturer offers such a broad range of silent and roller chains—of cast, combination, forged and fabricated types. And a complete selection of attachments permits efficient adaptation to varied services.

For help with any chain problem—big or small—call your local Link-Belt office. They are qualified to make an unbiased recommendation of the one chain best-suited to your exact needs.



LINK-BELT

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,089-A

NEW MORLIFE* CLUTCHES

*TRADEMARK

and

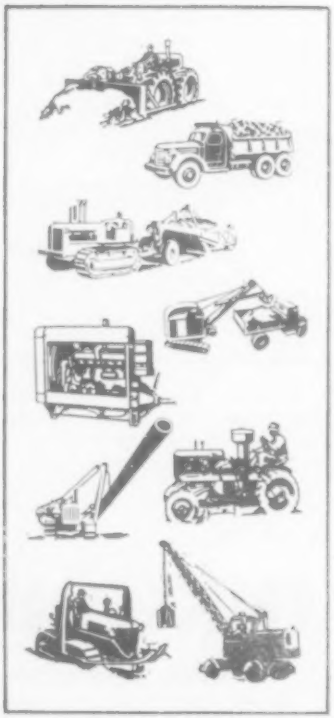
CLUTCH PLATES

Give—

100% MORE TORQUE GRIP
Reducing clutch size and engaging pressure

400% LONGER WORK LIFE
Operate longer without adjustment or plate replacement

50% BETTER HEAT DISPOSAL
Avoid down-time caused by burned or warped plates



These NEW type ROCKFORD clutches have been developed and field tested by Rockford Engineers for heavy-duty clutch service. Because of their specialized characteristics, MORLIFE type ROCKFORD clutches are best suited for use in off-the-road machines such as tractors, trucks, tanks, cranes, shovels, bulldozers, earth movers, pipe layers, power units and other heavy duty equipment. For information how this NEW development will improve the operation and increase the on-the-job hours of your heavy-duty machines, write Department E.

B. W. ENGINEERING MAKES IT WORK
ENGINEERING
B-W
PRODUCTION
B. W. PRODUCTION MAKES IT AVAILABLE

ROCKFORD Clutch Division BORG-WARNER

209 Catherine Street, Rockford, Illinois, U.S.A.

CYCOLAC®

THE *Newest* MOST ADVANCED HIGH-IMPACT THERMOPLASTIC STYRENE RESIN

for calendering, extrusion, and injection molding. Exceptionally suited for applications demanding high impact-strength, high heat distortion resistance, good electrical properties, low brittle point, dimensional stability, chemical resistance, light weight, bright colors and high gloss.

Properties of CYCOLAC

Property	Value	ASTM-Method
PHYSICAL AND MECHANICAL		
Rockwell, Hardness	R85	D785-51
Specific Gravity	1.01	
Tensile, psi	4500	D638-52T
Elongation, %	100 min.	D638-52T
Modulus of Elasticity (Tension), psi	196,000	D638-52T
Modulus of Elasticity (Flexure), psi	184,000	D790-49T
Compressive Yield Strength, psi	5100	D695-52T
Flexural Strength, psi	6800	D790-49T
Compression Set Under Constant Load:		D395-52T
22 hours @ 158°F., %	0.00	
70 hours @ 212°F., %	66.46	
Impact Strength		
Izod (notched) @ 73°F., ft. lbs.	4.80	D256-47T
Izod " @ 32°F., ft. lbs.	3.50	D758-48
Izod " @ −40°F., ft. lbs.	1.60	D758-48
Izod (unnotched) @ 73°F., ft. lbs.	48.0	
Izod " @ −40°F., ft. lbs.	36.0	D758-48
Charpy @ 73°F., ft. lbs.	6.43	
Shear Strength, psi	4100	D732-46
Bearing Strength, psi		D953-48T
*(1) @ 4%	4600	Procedure A for
(2) Maximum	18,600	Tension Loading
*Bearing strength at 4% deformation of bearing hole diameter.		
Mold Shrinkage	0.63%	
ELECTRICAL		
Dielectric Strength, short time:		D149-44
KV @ Breakdown	51	
Volts per Mil	416	
Dielectric Strength, step by step:		D149-44
KV @ Breakdown	51	
Volts per Mil	416	
Power Factor:		D150-47T
60_3 cycles	0.008	
10^3 cycles	0.009	
10^6 cycles,	0.009	
Dielectric Constant:		D150-47T
60_3 cycles	2.71	
10^3 cycles	2.68	
10^6 cycles	2.93	
Volume Resistivity, Ohm-Centimeters	8.2×10^{13}	D257-52T
Arc Resistance, seconds	82.3	D618-49T Procedure A
THERMAL		
Specific Heat	0.38	
*Coefficient of Thermal Expansion inch/inch/°C.	9.98×10^{-5}	D696-44
*Determined over a temperature range of −30°C. to +30°C.		
Heat-Distortion Temp., °F.	183.	D648-45T
Flammability, (inches/minute)	1.30	D635-44
Brittleness Temp., °F.	−45	D746-44T

Stress-Strain Properties:	77°F.	−70°F.	+170°F.	D759-58
Tensile, psi	4900	6990	2200	
Elongation, %	65	7	134	

Thermal Conductivity (K):	39°F.	77°F.	146°F.	C177-45
Btu/hour/sq. ft./°F./inch (samples 0.225 inches thick)	1.3	1.3	1.4	

Demolding Temperature — Approximately 212°–220°F.

CHEMICAL

CYCOLAC is almost completely resistant to aqueous acids, alkalies and salts. Concentrated sulfuric and nitric acids produce disintegration but concentrated phosphoric and hydrochloric acids have little effect. Low KB solvents, alcohols, and animal, vegetable and mineral oils produce insignificant changes. Glacial acetic acid, carbon tetrachloride, aromatic hydrocarbons and high KB solvents cause marked swelling. Esters, ketones and ethylene dichloride are solvents for CYCOLAC.

EVALUATED END USES FOR CYCOLAC

- Vacuum Sweeper Cover
- Clock Radio Cabinet
- Bowling Pin
- Lawn Mower Wheel
- Pipe Fitting
- Automobile Armrest
- Scale Housing
- Electronic Coil Form
- Portable Radio Cabinets
- Battery Case Cover
- Vacuum Drawn Display Sign
- Vacuum Drawn Letter Tray
- Extruded Sheets
- Extruded Piping
- Calendered Sheets
- Cases for Film Reels
- Television Tube Holder
- Saw Handles
- Safety Helmets
- Lawn Sprinkler Heads
- Golf Club Heads

MARBON CHEMICAL
GARY, INDIANA

A Division of BORG-WARNER CORPORATION

satisfied customers find willing ears!

GM GENERAL MOTORS Packard

REG. U.S. PAT. OFF. TRADE MARK

Packard Electric Division
General Motors, Warren, Ohio

The talk that willing ears hear does wonders for a manufacturer's reputation and sales. And the manufacturer who standardizes on Packard fractional horsepower motors for his appliances can be sure of starting a lot of satisfied talk among the girls.

Satisfaction comes from smooth, quiet, dependable performance . . . just what Packard Electric has been building into electric motors for more than 39 years. The appliance manufacturer who incorporates this satisfaction into his product benefits . . . from an added reputation as a builder of quality.

Here's the Complete "Package"

for Counting Electrically...

Added Evidence that —

Everyone Can Count on VEEDER-ROOT

This Veeder-Root Reset Magnetic Counter (AC or DC) is actuated through electromagnets. And it may be connected in series with any device having a contact arrangement . . . like the specially designed Veeder-Root Electrical Contactor at the left, which insures positive operation of the counter, either in oscillation or connected directly to a revolving shaft . . . with the counter placed at *any* distance from the machine or process on which the count is required.

This is another one of the hundreds of Veeder-Root Standard and Special Counting and Computing Devices developed for every conceivable counting duty, in every field from atomics to electronics.

What do *you* need to count? Just write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada •
Offices and Agents in Principal Cities
"The Name that Counts"

another revolutionary development by La Salle

THE NEW

. . . gives HIGH STRENGTH . . .

"FATIGUE-PROOF" steel bars offer high strength in-the-bar . . without the expense and trouble of heat treating. Tensile strength is in the 140,000 to 150,000 p. s. i. range . . hardness which is related to this strength level is approximately 30 Rockwell "C."

"FATIGUE-PROOF" has uniform strength across the bar . . no soft centers. (This uniformity is maintained from bar to bar . . lot to lot.) This remarkable uniformity of strength makes "FATIGUE-PROOF" ideal for applications in the 140,000 to 150,000 p. s. i. range that formerly required heat treated carbon and alloy steels, either hot rolled or cold drawn.

With "FATIGUE-PROOF" you'll get the advantages of heat treating . . none of the disadvantages. In short, you'll get a better part at lower cost.

. . . yet it's EASY TO MACHINE

"FATIGUE-PROOF" *is* a free-machining steel bar . . without question. It machines at least 25% faster than annealed alloys . . 50% to 100% faster than heat treated alloys.

"FATIGUE-PROOF's" excellent machinability permits faster speeds, heavier feeds, better tool life . . your production rates will increase . . you'll get more parts per hour.

Distortion from machining is held to a minimum . . there is no reduction of tool life due to the higher speeds and heavier feeds . . and surface finish is greatly improved.

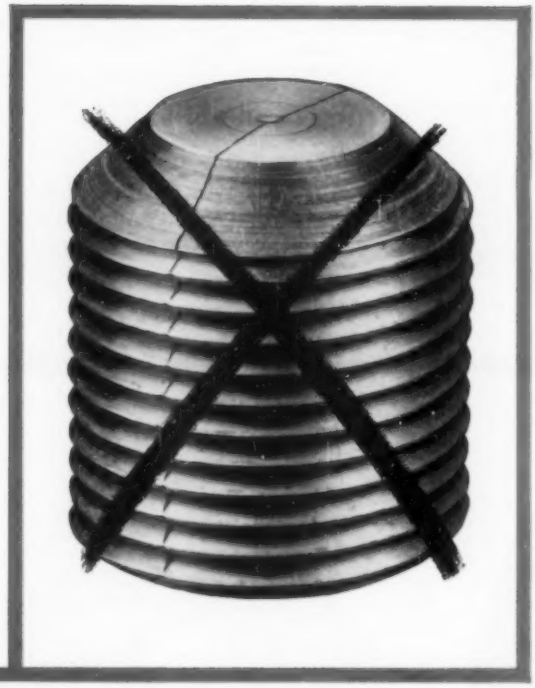
La Salle STEEL CO.

1430 150th Street, Hammond, Indiana

Manufacturers of America's Most Complete Line of *Quality* Cold-Finished Steel Bars

fatigue-proof STEEL BAR

WITHOUT HEAT TREATING



- *no quench cracks*
- *no distortion from heat treating*

With heat treating eliminated, the problems that accompany heat treating are avoided. Quench cracks become a thing of the past. Distortion and warpage from heat treating don't occur . . consequently time consuming and costly straightening and cleaning operations are not necessary.

You eliminate not only the cost of heat treating but also its disadvantages.

If you have parts where strength is a requirement . . you can save money and get away from problems by using "FATIGUE-PROOF." Our Sales Engineers will be happy to show you how this can be accomplished and provide samples for test purposes.

JUST PUBLISHED! Ask for your copy of the new 20-page booklet which gives additional information on the remarkable new "FATIGUE-PROOF."

LA SALLE STEEL CO.
1430 150th Street
Hammond, Indiana

Please send me your "FATIGUE-PROOF" Bulletin.

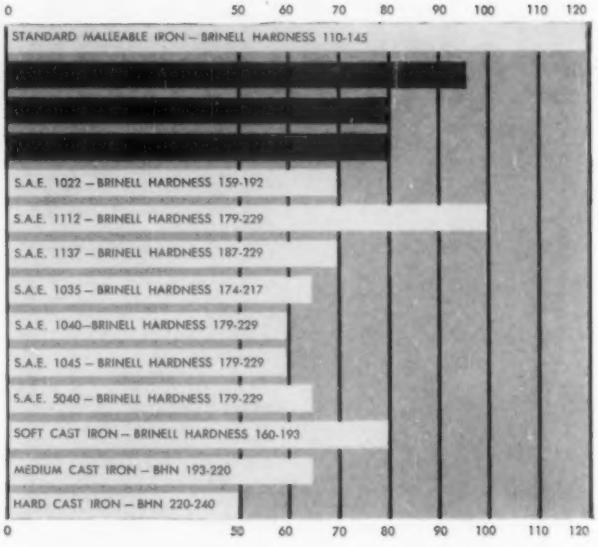
Name_____
Title _____
Company_____
Address_____
City_____ Zone____ State_____

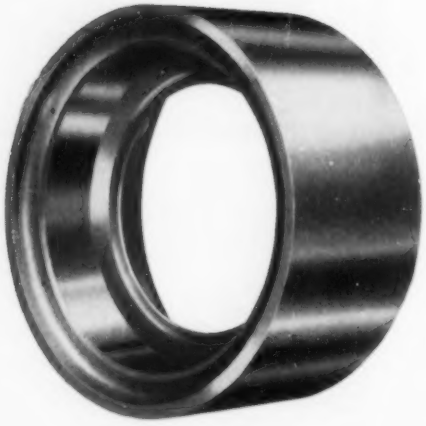
ARMASTEEL®

ArmaSteel's machinability makes it outstanding in the ferrous field. In general, its rating is from 10% to 30% better than bar stock or forgings of the same Brinell hardness. One of the reasons for this rating is the structure, which consists of a matrix of sorbitic-pearlite and spheroidized cementite in which small nodules of carbon are imbedded. Because of this the chips break off more readily in machining operations whether it be turning, drilling, milling or broaching.

The machinability rating of a metal is not absolute—its rating can be stated only in relation to that of another metal. To establish the accompanying machinability rating table Bessemer screw stock S.A.E. 1112 is used as the base. In establishing these ratings, the cutting speed of the S.A.E. 1112 is the rate generally used in turning this metal on automatic screw machines. The rate of feed, however, is altered to that necessary to attain normal tool life and good surface finish when using a coolant. When the other metals are tested, the feeds and speeds are varied from these basic rates to whatever rate is necessary to obtain comparable tool life and comparable surface finish. The ratio of these rates of speeds and feeds

MACHINABILITY RATING (PER CENT)





castings are easier to machine*

of each tested metal determines the percentage of machinability.

ArmaSteel is a versatile pearlitic malleable iron that combines the advantages of both castings and forgings. ArmaSteel parts can be cast by conventional sand method or shell mold process to relatively close dimensions in large quantities at low cost. Because of the excellent, accurately controlled physical properties of ArmaSteel, these parts have the strength and performance characteristics usually associated with plain carbon steel forgings.

ArmaSteel is produced in three ranges: ArmaSteel 84M, ArmaSteel 85M and ArmaSteel 86M with a wide variety of physical properties uniformly maintained through accurate heat treating operations as follows:

ARMASTEEL 84M is recommended where a high degree of strength is necessary. It usually replaces heat-treated steel parts in the 1040-1050 S.A.E. range. It has a hardness range of BHN 241-269 or 3.7-3.9mm. impression with a 3000 Kg. load. Tensile strength is 100,000 p.s.i., yield strength is 80,000 p.s.i., and percent of elongation in 2" is 2.0%.

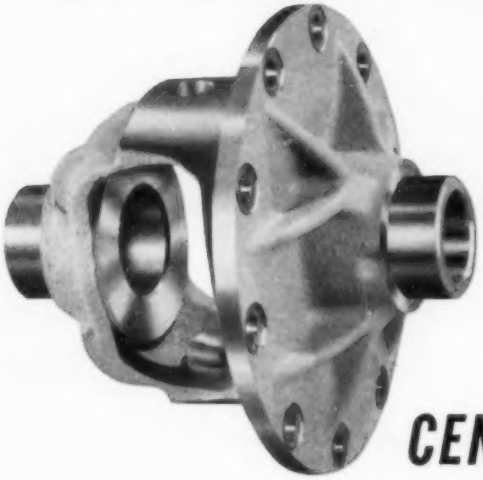
ARMASTEEL 85M is recommended where moderate strength is required and where selective hardening is necessary. This class usually replaces parts in the 1035-1050 S.A.E. range. It has a hardness range of BHN 197-241 or 3.9-4.3 mm. impression with 3000 Kg. load. Tensile strength is 80,000 p.s.i., yield strength is 60,000 p.s.i., and percent of elongation in 2" is 3.0%.

ARMASTEEL 86M is recommended for less highly stressed parts usually replacing steel parts in the 1020-1035 S.A.E. range. It has a hardness range of BHN 163-207 or 4.2-4.7 mm. impression with 3000 Kg. load. Tensile strength is 70,000 p.s.i., yield strength is 48,000 p.s.i., and percent of elongation in 2" is 4.0%.

The FOUR parts illustrated below are typical of the hundreds of different parts and products successfully produced in ArmaSteel for many diversified industries.

Write, today, for new 70 page comprehensive catalog . . . or request personal help from our experienced engineers, without obligation.

*When compared with medium carbon steel forgings.



CENTRAL FOUNDRY DIVISION · GENERAL MOTORS CORPORATION

58

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 10

Republic Stainless cuts cost of

Operator at left is removing scale accumulation from Clepco immersion heater casing made from Republic ELECTRUNITE® Stainless Steel Tubing. Any normal cleaning procedure may be followed without risk of damage to unit. And if your product demands cleanliness, the lustrous, smooth-finished surfaces of stainless tubing are clean, sanitary, and easy to keep that way. Solid stainless throughout, maintenance and replacement costs are reduced.

Operator at right is shaping 2" Republic ELECTRUNITE Stainless Steel Tubing to a bullet nose by spinning it under flame. Workability of this tubing makes it easy to fabricate. For heater casings, Cleveland Process uses both Types 304 and 316 Stainless Tubing which they find highly satisfactory for either acid or alkaline solutions—at temperatures ranging from 100° to 600°.

REPUBLIC

REPUBLIC STEEL

World's Widest Range of Standard Steels

Tubing solves breakage problem...

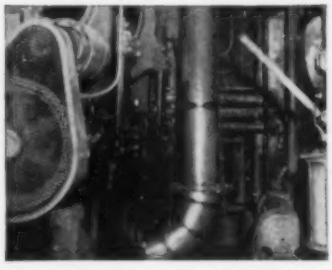
Clepco immersion heater casings

The Cleveland Process Company of Cleveland, Ohio, manufacturers of Clepco immersion heaters, had a twofold problem. The tube-like casings they use to house heating elements were fabricated from a brittle imported material. Scale removal was particularly hazardous—often resulting in a cracked or broken casing. Furthermore, the material itself, although an effective insulation, was expensive.

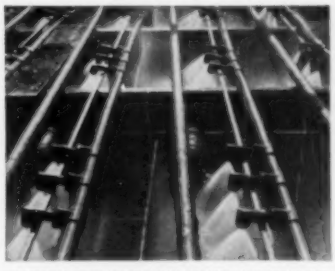
To solve these problems, Cleveland Process switched to Republic ELECTRUNITE Stainless Steel Tubing for heater casings. They found ELECTRUNITE Stainless Tubing easy to fabricate, having consistently uniform diameter, wall thickness, concentricity, strength and ductility. But most important, ELECTRUNITE completely eliminated breakage and substantially reduced material costs.

Made of long-lasting Republic ENDURO Stainless Steel, this tubing provides strong resistance to corrosion, oxidation and scaling at high temperatures. Where strength is a requirement ELECTRUNITE Stainless Tubing is ideal—providing an extremely high strength-to-weight ratio.

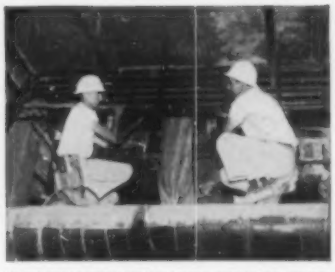
This tubing may be the very material you need to improve your product or process. For detailed information about the many cost-saving advantages of Republic ELECTRUNITE Stainless Steel Tubing—including sizes, gages and analyses—send coupon today for new, illustrated 60-page booklet.



REPUBLIC ENDURO® STAINLESS PIPE SAVES COSTS in paper mills. Section shown above is part of a piping system that conveys the highly corrosive pulp mixture to the processing machines. Where corrosion-resistance is vital to cost savings, the extra expense of this long-lasting piping is an inexpensive investment in long-range economy.



REPUBLIC SEMI-RIGID PLASTIC PIPE SAVES COSTS in cooling towers. Original pipe had to be replaced every four months in this cooling installation near coke ovens. A constant bath of corrosive steam saturated with hydrochloric acid soon destroyed it. Two years ago, Republic Semi-Rigid was installed with excellent results: no sign of damage to this date.



REPUBLIC DEKORON®-COATED EMT SAVES COSTS of electrical conduit in chemical plants. Wherever the atmosphere is corrosive, unprotected metal parts take a beating. But Dekoron-Coated EMT shrugs off corrosion. The tough, polyethylene coating over the galvanized finish gives double protection to electrical raceways. Send coupon for facts.

STEEL

and Steel Products

REPUBLIC STEEL CORPORATION
3150 East 45th Street • Cleveland 27, Ohio

Please send me more information on:

- ☐ Republic ELECTRUNITE Stainless Steel Tubing
- ☐ Republic ENDURO Stainless Pipe
- ☐ Republic Plastic Pipe
- ☐ Republic Dekoron-Coated EMT

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

R-9089

The world's largest opens a new era of

ABOUT one year ago, the largest die-casting machine in the world was completed and put into operation by Doehler-Jarvis Division of National Lead Company in cooperation with Kaiser Aluminum & Chemical Corporation.

Recently, the huge machine successfully produced the largest aluminum die-casting ever made—a six-cylinder in-line engine block weighing about 130 pounds less than a similar gray iron block.

The successful production of such a large and complex die-casting points the way to the design of large and economical die-cast aluminum parts for many industries.

Such parts would benefit from all the advantages of the die-casting process, which is inherently suited for mass production of parts requiring close dimensional tolerances, smooth surfaces, clean and sharp detail and thin metal sections.

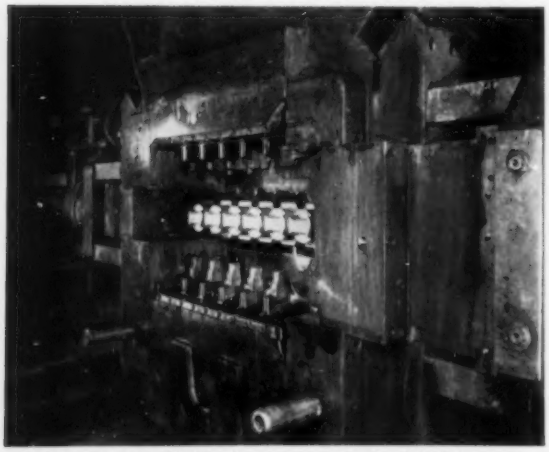
It is also possible to cast many details to size on the large press. In many cases, this eliminates the need to drill holes and other machining operations. Threads may often be cast to size, thus eliminating a threading operation. Cast-in metal inserts are readily included in die-castings.

Overall dimensional accuracy is another feature of die-castings that is important to many parts. This reduces the amount of finish allowance when parts are machined to a prescribed overall dimension.

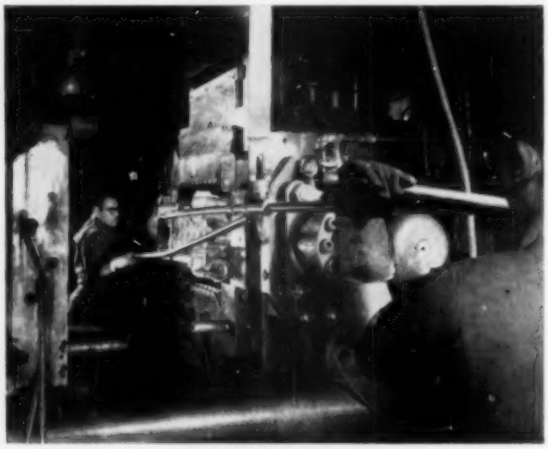
In addition, die-castings are generally lighter in weight than the equivalent parts made in sand or permanent mold, because thinner metal sections and less draft are permissible.

The metal quality of die-casting is more uniform than in a typical sand casting. Therefore, service life is more uniform.

Product designers and engineers should investigate this new Doehler-Jarvis Division of National Lead development in aluminum die-casting without delay to see if your existing or new designs can take advantage of the new 72" machine.

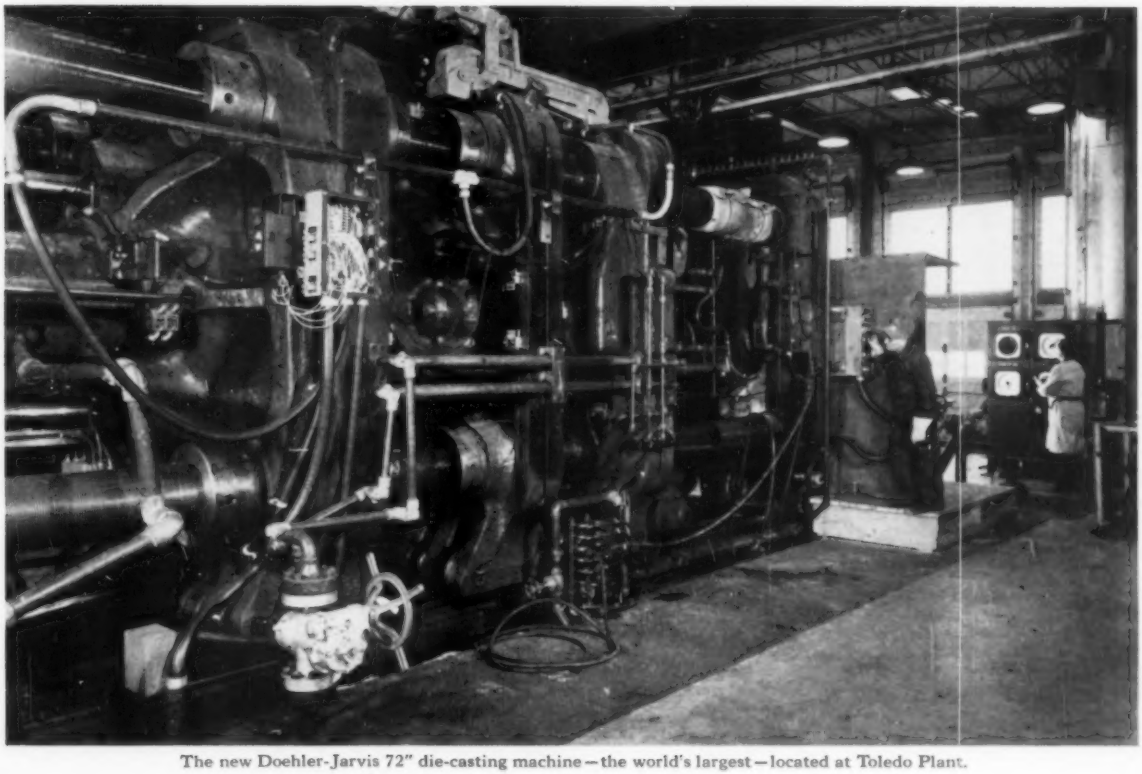


Machine open with dies for aluminum engine block in place.



Aluminum engine block being lifted from die after cast.

die-casting machine product design!



The new Doehler-Jarvis 72" die-casting machine—the world's largest—located at Toledo Plant.

Engine blocks were die cast by Doehler-Jarvis.

If you need assistance with aluminum . . .

Let us work in partnership with you. We are eager to share our knowledge of aluminum and engineering skill. Development engineers will gladly provide engineering service and counsel on design and alloy selection which may give you a better product at a lower cost. Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Illinois; *Executive Office*, Kaiser Bldg., Oakland 12, California; DETROIT OFFICE, *1414 Fisher Bldg., Detroit 2, Michigan, Phone Trinity 3-8000.*

Kaiser Aluminum

setting the pace—in growth, quality and service

Why shop around? REEVES

REEVES

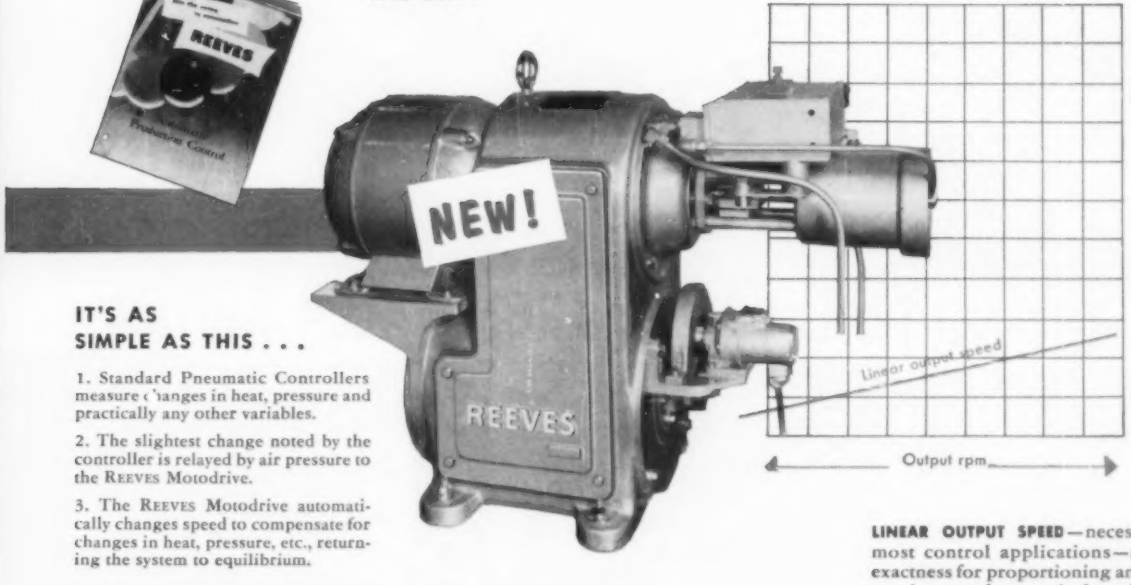
Recognized Leader in the specialized field of variable speed control

REEVES FLEXI-SPEED . . . *with new low speeds!*

Amazing *new* Flexi-Speed is but one outstanding example of the complete line of REEVES Variable Speed Drives. Now available with output speeds from 300 rpm to 4800 rpm—speed ratios as great as 8:1. Combines efficiency, versatility and *low price.*

offers the only complete line of variable speed drives and automatic controls

FREE! REEVES *New* Automatic Production Control Booklet — Specify K4b-G537.



IT'S AS SIMPLE AS THIS . . .

1. Standard Pneumatic Controllers measure changes in heat, pressure and practically any other variables.
2. The slightest change noted by the controller is relayed by air pressure to the REEVES Motodrive.
3. The REEVES Motodrive automatically changes speed to compensate for changes in heat, pressure, etc., returning the system to equilibrium.

LINEAR OUTPUT SPEED—necessary to most control applications—assures exactness for proportioning and gives precise speed control *throughout the entire range* of the Motodrive.

REEVES AUTO-PNEUMATIC CONTROL

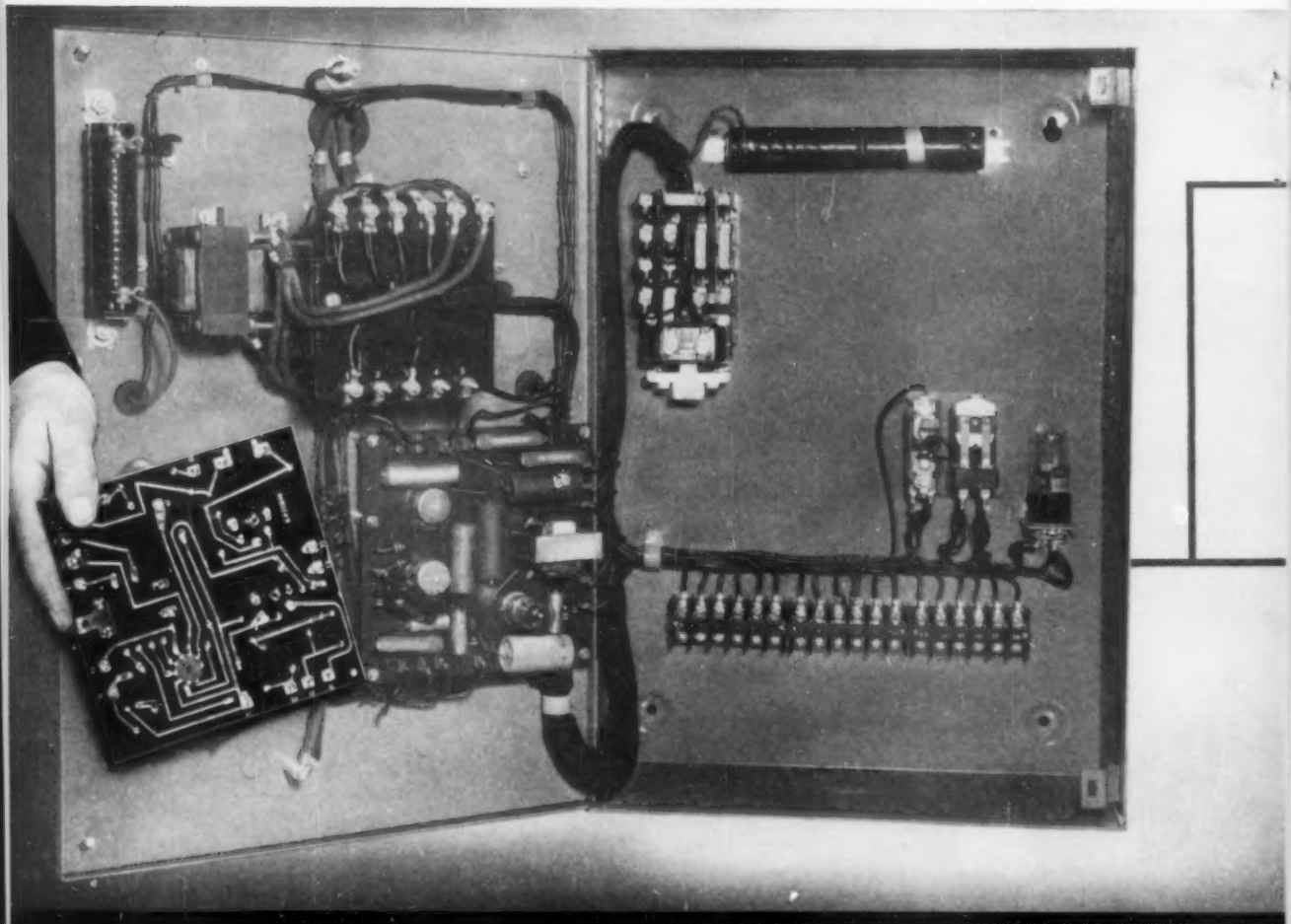
for regulating flow, pressure, heat, etc.

REEVES PULLEY COMPANY • COLUMBUS, INDIANA

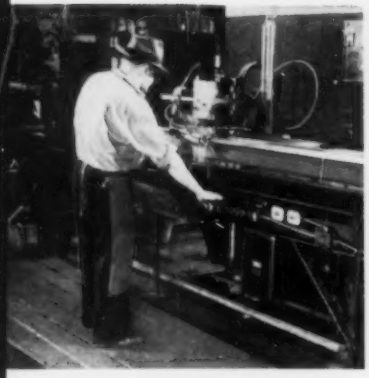
Division of **RELIANCE ELECTRIC AND ENGINEERING CO.**

GENERAL ELECTRIC ANNOUNCES ADDITION TO THY-MO-TROL*

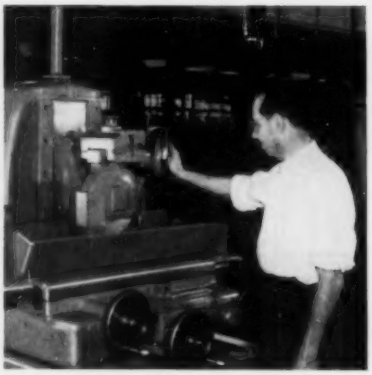
NEW Low-priced 3/4-3 HP



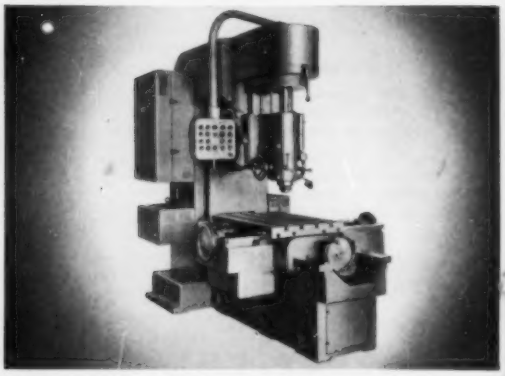
G-E THY-MO-TROL DRIVES ARE IDEALLY SUITED



Electronic Induction Heater. Thy-mo-trol Drive moves the carriage to exact pre-set conditions to assure uniform heat treatment.



Surface Grinder. All motions on this grinding machine are controlled by General Electric's Thy-mo-trol Drive: spindle, table and cross-feed operations.



Milling Machine. Thy-mo-trol Drives automatically step up production on this milling machine by giving correct speeds for spindle, table and spindle head drive requirements.

DRIVE LINE . . .

Thy-Mo-Trol Drive with Printed Circuitry

NOW! FOR MACHINE TOOL APPLICATIONS —A RELIABLE, SIMPLIFIED, ADJUSTABLE SPEED DRIVE

These new, simplified General Purpose, 3/4-3 HP Thy-mo-trol Drives have been developed for industrial applications demanding wide speed range and close speed regulation. Embodying all the smooth adjustable speed characteristics of DC drives, the two models offer greater performance, reliable operation and wide speed range selection for many industrial applications.

A PRICE REDUCTION, due largely to G.E.'s industrial application of printed circuitry has been made. The entire control system has been simplified, giving the user substantial reductions in over-all weight, size, circuit complexity, amount of wiring, maintenance costs and installation costs.

OPERATING DIRECTLY FROM AC POWER, the new Thy-mo-trol Drives can increase machine production on most applications because they • Give the correct speed for the required operation • Reduce operating spoilage and rejects because of high accuracy performance and • Increase machine versatility because of the wide speed range and close speed regulation features offered.

THE COMPLETE THY-MO-TROL DRIVE LINE COVERS ratings from 1/40 to 30 HP and beyond. Speed ranges of 5:1, 20:1, 50:1, and 100:1 are typical. Speed regulation of $\frac{1}{2}$ of 1% is possible over the entire speed range.

SIMPLIFIED FRACTIONAL HORSEPOWER THY-MO-TROL DRIVES are supplied as half-wave or full-wave units, allowing a wide selection of performance standards to meet each particular industrial application.

HIGH PERFORMANCE INTEGRAL HP THY-MO-TROL DRIVES, 3/4-30 HP, full-wave offer these superior performance features: greater flexibility, rugged industrial-type construction, easy maintenance, wide speed range, adjustable current limit, flat speed regulation and optional features such as: jogging, quick slowdown, reversing, dynamic braking, tachometer feedback and position synchronization all add up to qualify these drives for many machine tool and industrial applications.

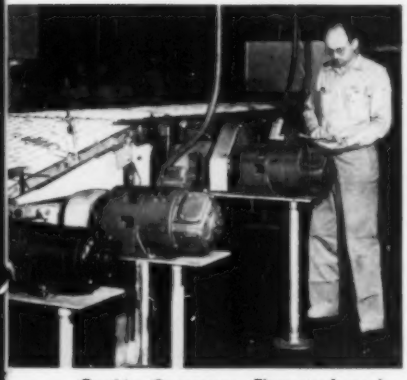
FOR MORE INFORMATION on General Electric's Thy-mo-trol electronic adjustable speed drives, contact your nearest G-E Apparatus Sales Office or write for Bulletins GEA-6234, GEA-4089, GEA-5179, GEA-5827 and GEA-5337—General Electric Company, Schenectady, N. Y. 791-2

Progress Is Our Most Important Product

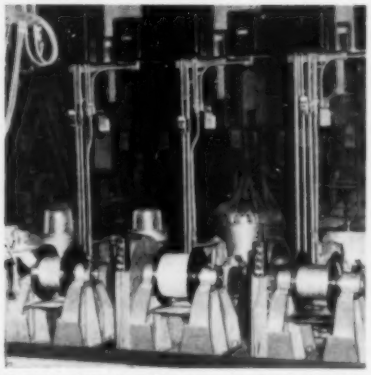
GENERAL ELECTRIC

® Reg. Trade-mark of General Electric Company.

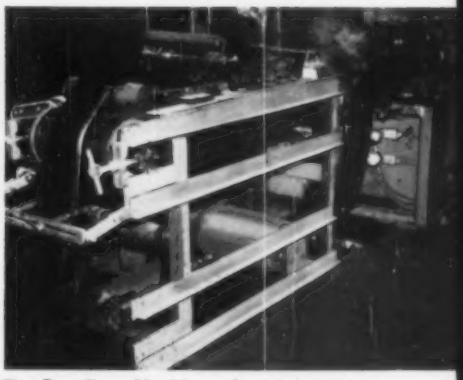
TO THESE TYPICAL INDUSTRIAL APPLICATIONS



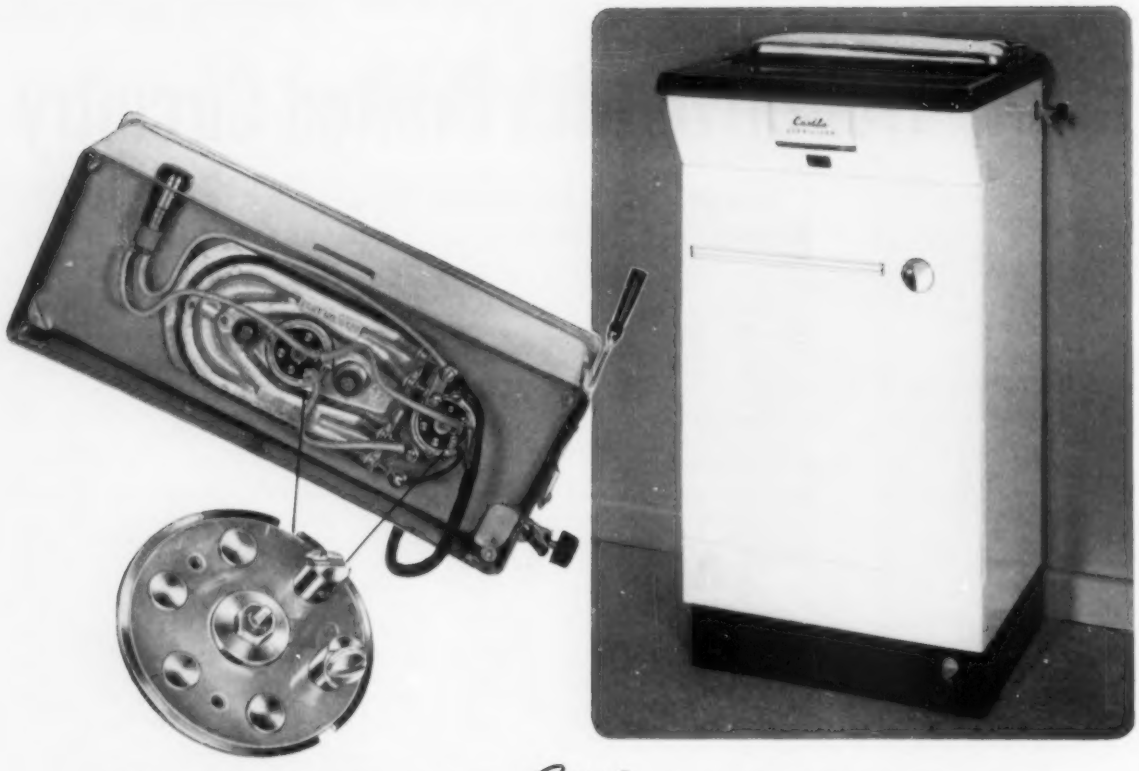
Cookie Conveyor. Repeated variations in speed—necessary to meet baking requirements—are easily handled by Thy-mo-trol Drive.



Wire Re-Winder. As the coil of wire builds up, Thy-mo-trol Drive continually adjusts speed of reel to maintain constant winding at maximum speed.



Tire-Treading Machine. A continuous strip of tire-tread passes from extruder (in background) to conveyor. Thy-mo-trol Drive synchronizes the operation.



KLIXON *Thermo Snap*® CONTROLS

"Used Continuously Through 27 Years in Castle Sterilizers for Accuracy and Dependability"

For over fifty years, the Wilmot Castle Company of Rochester, New York, has specialized in quality sterilizers for physicians, hospitals and dentists. And today, Castle equipment is the recognized standard.

Since first used in 1927, Klixon Thermo-Snap Temperature Controls have helped Castle maintain this enviable reputation by providing accurate, dependable performance. Mr. David Bellamy, Advertising Manager, writes:

> "This company began using the "Klixon" Thermostatic Control in 1927. It was chosen then as a revolutionary idea for direct control of electric current because its speed and surety of action eliminated hazards then common to mechanical thermostats.
>
> "That early confidence has been proven justified through 27 years of continuous use in Castle Sterilizers."

Designers and manufacturers seeking accuracy and efficiency in temperature control rely more and more on Klixon Thermo-Snap Controls, actuated by the famous Spencer Disc.

What's your temperature control problem . . . low and high temperature limitation, fuel delay switches, tube and rectifier cooling thermostats, fan switches, appliance controls . . . Klixon Thermo-Snap Controls are meeting hundreds of requirements for these and other applications in military and civilian products, daily.

Klixon Thermo-Snap Controls are available in many hermetically sealed and open types in a wide variety of operating temperature ranges.

Our Field Engineers, specialists in temperature control applications, can help you work out your specific application details. Write for their help or further information without obligation.

Typical Klixon Thermo-Snap Controls that can help you solve your Temperature Control Problems

KLIXON

METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
901 Forest Street, Attleboro, Massachusetts

TRUFLEX® Thermostat Metal Coils Over ⅛ Mile Long in One Piece Simplify Fabrication and Reduce Costs in Thermal Element Manufacture

The problem . . . to obtain thermostat metal strip in a series of types having sufficiently uniform dimensional control and temperature response to be fabricated into finished parts on automatic machines.

The solution . . . Step 1; the consistent quality of each type of TRUFLEX tested quickly demonstrated that mass production by machine was fully practical for all types.

Step 2; General Plate Division then supplied the required types in long coils 3 feet in diameter with center hole to fit the customer's automatic machine arbors. Each coil is a continuous piece 1800 feet long, by 0.040" thick and 0.250" wide.

These coils save the customer many dollars by minimizing idle machine time and eliminating costly waste of material in fabrication.

If your products require temperature control . . . indication or compensation, the accurate performance and uniform high quality of TRUFLEX Thermostat Metals will save you money too.

Here's why! General Plate Division uses advanced production methods, combining the best equipment available with years of manufacturing "know how", to insure positive consistence in thermal and mechanical performance of TRUFLEX Thermostat Metals.

General Plate Division will fabricate parts from TRUFLEX to meet the specific mechanical and electrical performance demands of your particular applications. Or, if you prefer to make your own parts, General Plate Division will supply TRUFLEX Thermostat Metal in strip to meet your specifications.

Write today for your copy of the new TRUFLEX Thermostat Metal Catalog. Engineering assistance available without obligation.

GENERAL PLATE ELECTRICAL CONTACT KIT FOR LABORATORY AND DEVELOPMENT USE

Kit K11 contains a wide assortment of silver rivet contacts; Kit K12 has representative standard button contacts. Also included are metal strips for fabrication of contact parts. These kits are available at nominal cost.

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
11 FOREST STREET, ATTLEBORO, MASS.

You can profit by using General Plate Composite Metals!

Your Design Problems

PROBLEM: Lay Out Piping Most Economically

PROBLEM: Adapt One Pump to All Units

PROBLEM: Stocking Too Many Models

PROBLEM: Mounting Method Restrictions

SOLVED

by ALLIS-CHALMERS Pump Specialists

Your Allis-Chalmers representative is an experienced, highly qualified pump specialist who will give you full cooperation — from planning to purchasing to production. He will help you select exactly the right pump to fit your requirements from Allis-Chalmers wide range of types and sizes.

The A-C expert will gladly give you as much help as you need in engineering your setup. He may be able to make valuable suggestions which will result in savings of time, money, effort, or in a better product.

Once your equipment goes into the field, Allis-Chalmers nationwide network of Certified Service Shops assures fast service wherever the user may be, relieving you of part of your service problem.

Allis-Chalmers OEM pumps are available from strategic stocking points all over the country. Contact your A-C District Office for details on how to expedite pump selection and ordering, or write Allis-Chalmers, Milwaukee 1, Wis., for more information.

A 4753

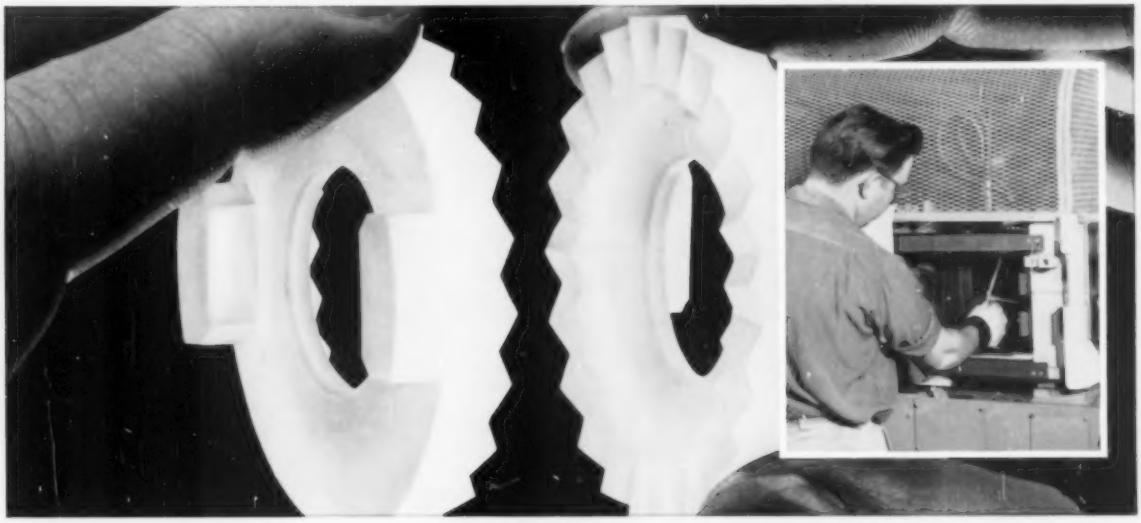
ALLIS-CHALMERS

DU PONT
REG. U.S. PAT. OFF.
Better Things for better living ... through Chemistry

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Clutch facings of ZYTEL® nylon resin are economically injection molded...last 5 times longer than metal parts replaced



Parts of "Zytel" like these clutch facings can be mass-produced by injection molding (see inset) in multi-cavity dies—a fast, efficient method of fabricating, which generally requires no after-finishing. (Clutch facings molded by Danielson Manufacturing Company, Danielson, Connecticut.)

THIS CLUTCH revolves at 1750 rpm, transmitting 75 ounce-inches of torque. It is engaged and disengaged up to 40 cycles a minute, 24 hours a day. Minnesota Mining & Manufacturing Company, St. Paul, Minnesota, formerly used heat-treated metal facings for this heavy-duty job, but had to replace them an average of 17 times a year. After a change to facings molded of tough, wear-resistant "Zytel" nylon resin, replacements were required only *three times a year!*

The metal clutch components cost $8.75 apiece. Those of "Zytel" are 32¢ each. The savings realized on the first 91 facings of "Zytel" covered the costs of the die required to mold these precision parts. Minnesota Mining & Manufacturing Company estimates an annual saving of $150.00 per clutch installation, to which can be added savings which accrue from only three machine shutdowns a year instead of seventeen.

This kind of efficiency and economy can be yours if you examine the properties of "Zytel". Designers and engineers have found endless uses for this versatile material. Some of the many successful applications of "Zytel" are bearings, gears, cams, rollers and bushings. Learn more about the resilience, heat resistance, and strength of "Zytel". Apply its combination of properties to your product needs. For information on Du Pont "Zytel", mail the coupon on the next page.

OVER

The protective shield of "Lucite" acrylic resin on this Kalart flash attachment was molded by T. F. Butterfield, Inc., Naugatuck, Connecticut.

Crystal-clear safety shield of LUCITE® protects against flashbulb shatter

BECAUSE it is transparent and durable, "Lucite" acrylic resin offers outstanding advantages. Its high impact strength and weather resistance afford long wear and heavy-duty service. "Lucite" gives optimum transparency and can be colored to provide unusual decorative effects.

An interesting application of this engineering material is in the new Kalart flash attachment. "Lucite" is used for a safety shield protecting subjects from possible shatter of flashbulbs. Economically molded, "Lucite" withstands heat without discoloring.

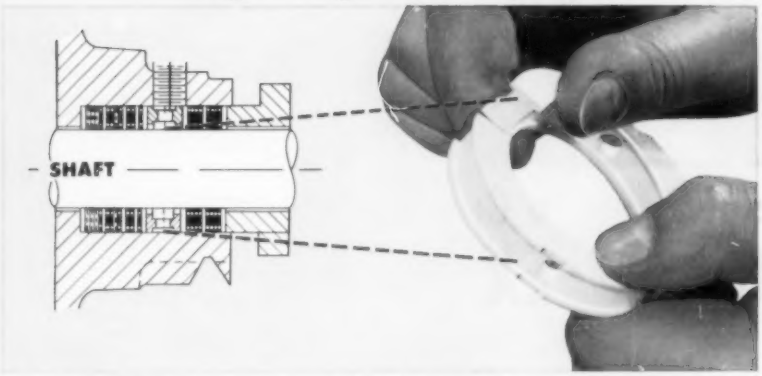
DU PONT
REG. U.S. PAT. OFF.

Better things for better living ... through Chemistry

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Du Pont TEFLON® for flexible seal cages which snap in place easily, won't score shaft



Effective sealing without danger to the shaft is possible with seal cages of "Teflon". These flexible cages snap on and off quickly and give long wear under rugged conditions. (Manufactured by Chemical and Power Products, Inc., New York, New York.)

"Teflon" is strong and chemically inert through a wide temperature range

THESE flexible seal cages of Du Pont "Teflon" tetrafluoroethylene resin supply annular space in packing for lubrication with oil or grease, or for cooling. Users of pumps and other process equipment will appreciate how quickly and easily these flexible seal cages of "Teflon" snap on and off a shaft. They're tough—won't bend or collapse under extreme gland pressure. Yet, because "Teflon" is non-adhesive, there's no danger of a scored shaft or sleeve from these seal cages.

"Teflon" is used extensively in chemical, electrical and mechanical applications. Its chemical inertness, high heat resistance ("Teflon" operates in many applications at temperatures as high as 500° F.), low temperature toughness, and low coefficient of friction make this engineering material particularly adaptable to severe service conditions. Possibly "Teflon" can solve an engineering problem for *you*.

Shield of ALATHON® solves insulation problem in new RCA Victor color TV receiver

THE PICTURE TUBE in the new RCA Victor color television receiver operates at 25,000 volts. To provide insulation for this tube, RCA engineers needed a material that could be readily and inexpensively molded into the complex shape of a kinescope shield . . . yet had high dielectric strength. Du Pont "Alathon" polyethylene resin proved to be an ideal material for the shield on all counts. In addition to providing the needed insulation, the shield of "Alathon" gives mechanical protection to the tube when it is shipped or handled.

"Alathon" not only has excellent insulating properties but is strong, lightweight and

flexible. It is chemical resistant, as well as odorless, tasteless and non-toxic. Because of these properties, and the ease with which parts can be molded, extruded or fabricated, "Alathon" has helped engineers solve many design and operating problems.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 101, Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada, Ltd., P. O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel";* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite". I am interested in evaluating these materials for:*

NAME _____ POSITION _____

COMPANY _____

STREET _____

CITY _____ STATE _____

TYPE OF BUSINESS _____

*"Alathon", "Lucite", "Teflon" and "Zytel" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)

Investigate DuPont engineering materials in your product development programs

One of the family of these versatile engineering materials is often a key factor in product improvement or new product design. The wide range of properties, available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"* nylon resin, are helping solve industrial design problems.

NEED MORE INFORMATION? Clip the coupon for additional data on the properties and application of these Du Pont engineering materials.

Pushed for Greater Drafting Room Output?
Modern Reproduction Machines Will Help You Get It!

NOW Is the Time to Get Your New, Modern BRUNING COPYFLEX MACHINE!

The boom in production means more pressure than ever for engineering drawings and prints. Right now is the time to replace that old inadequate reproduction machine you've been putting up with — now's the time to get a modern, efficient Bruning Copyflex.

In just the last year, Bruning has introduced five new, advanced machine models, one of which is shown at the right. These machines offer you the famous problem-free installation and operation of Copyflex . . . no exhaust venting, no plumbing or auxiliary equipment, no installation other than an electrical connection. They bring you faster reproduction speed and a host of operator conveniences such as fast return of originals, automatic separation, front or rear delivery. They are the efficient, economical, modern reproduction machines that will help you boost your drafting room output, keep costs at a minimum.

Now is the time to act. Mail the coupon below. You'll be glad you did!

Copyflex Model 500
A new, ultra-fast, heavy-volume machine offering top mechanical speed of 40 f.p.m., automatic separation, front or rear delivery, automatic stacking, and a host of other advanced features.

BRUNING Copyflex

Best Process! Best Machines! Best Selection of Materials!

Specialists in Copying Since 1897

CHARLES BRUNING COMPANY, INC., 4700 Montrose Ave., Chicago 41, Illinois
In Canada: Charles Bruning Company (Canada) Ltd., 105 Church St., Toronto 1, Ont.

Charles Bruning Company, Inc., Dept. 13-O
4700 Montrose Ave., Chicago 41, Illinois

Please send me information on Copyflex process and Model 500 machine.

Name _____ **Title** _____

Company _____

Address _____

City _____ **County** _____ **State** _____

NOW... it's 5 to 9!

Asarco now offers continuous-cast bronzes in 32 new sizes from 5 inches to 9 inches in diameter, supplementing established sizes up to 5 inches in diameter.

You can buy Asarcon Bronzes cored or solid *in the exact length you need*. You pay for no short-end scrap because there are none of the remnants you get from conventional 12-inch or 13-inch lengths.

Diameters of Asarco Continuous-Cast Bronzes now range from ½ inch to 9 inches in any size you need . . . many foundry alloys and a variety of shapes are available in all of these sizes. The famous "Asarcon 773" Bearing Bronze (SAE 660) can be shipped promptly from stock.

All bronzes produced by the patented Asarco continuous-cast process are metallurgically superior. There are no blowholes or porosity, no dross or dirt inclusions.

Write to us for more details, or get in touch with your nearby distributor of Asarco Continuous-Cast Bronzes.

ASARCO

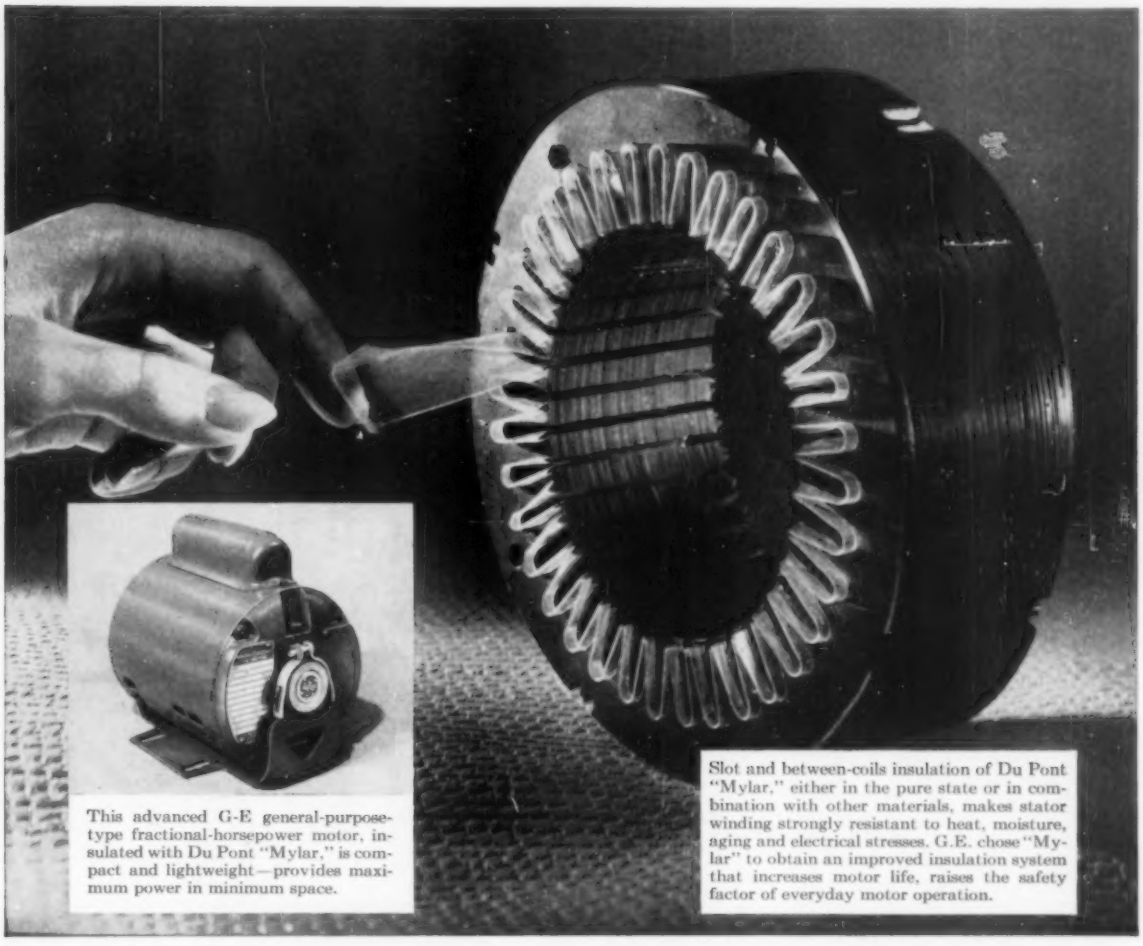
AMERICAN SMELTING AND REFINING COMPANY

Perth Amboy Plant, Barber, New Jersey • Whiting, Indiana

WEST COAST SALES AGENT: Kingwell Bros. Ltd., 457 Minna Street, San Francisco

IN CANADA: Federated Metals Canada, Ltd., Toronto and Montreal

SUPERIOR... Electric Motors Insulated With Du Pont MYLAR*



This advanced G-E general-purpose-type fractional-horsepower motor, insulated with Du Pont "Mylar," is compact and lightweight—provides maximum power in minimum space.

Slot and between-coils insulation of Du Pont "Mylar," either in the pure state or in combination with other materials, makes stator winding strongly resistant to heat, moisture, aging and electrical stresses. G.E. chose "Mylar" to obtain an improved insulation system that increases motor life, raises the safety factor of everyday motor operation.

CHALLENGING to industry: countless opportunities for product improvements with this versatile new film.

Combining high dielectric strength and moisture resistance, Du Pont "Mylar" polyester film helps General Electric obtain a superior insulating system. "Mylar" is now used as slot and between-coils insulation of the G-E advanced motor line—helps make possible a modern, improved type of insulation that increases motor life and insures better motor protection. "Mylar" gives these motors maximum protection against heat, moisture and deteriorants.

These G-E motors are an outstanding example of the way industry is putting versatile "Mylar" to profitable use. "Mylar" is the strongest of all plastic films—has an unusual combination of physical, electrical, chemical, and thermal properties never before available in a plastic film. In a remarkable diversity of fields, Du Pont "Mylar" is making possible better products, lower costs.

It may take only a little creative research to show *you* where you can use Du Pont "Mylar" to develop or improve a product. Mail coupon for free copy of a booklet that gives you the details on this valuable film.

*"Mylar" is the registered Du Pont trade-mark for its brand of polyester film.

DU PONT MYLAR® POLYESTER FILM

DU PONT

Better Things for Better Living...*through Chemistry*

E. I. du Pont de Nemours & Co. (Inc.)
Film Department, RoomP-1, Nemours Bldg.
Wilmington 98, Del.

Please send me sample and further information on "Mylar" polyester film.

Name_____

Firm_____

Street Address_____

City_____ State_____

Pressur-Forming

ASSURES A BETTER FIT, GREATER STRENGTH, LONGER LIFE

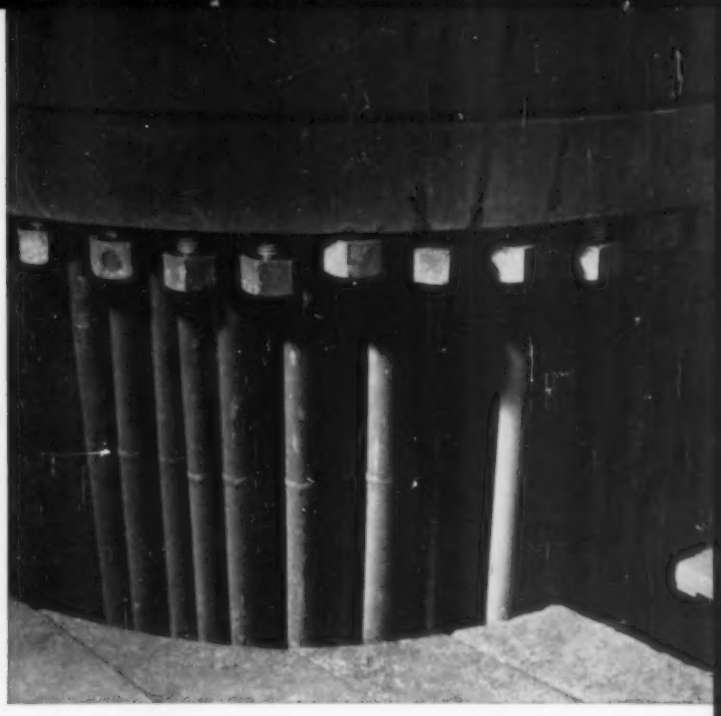
ALLEN originated the cold forging method of precision screw production. Today's advanced methods result in a combination of tremendous strength, fatigue resistance and precision.

Pressur-forming preserves the tough fibers of Allenoy steel continuous, uncut and concentrated where strength is needed most . . . conforming to the contours of head, socket and threads.

NOW WITH THE LEADER POINT Allen's exclusive unthreaded leader point makes starting easier and protects against cross threading or damage if the screw is accidentally knocked or dropped. Your Allen Distributor provides a "local warehouse" for Allen fasteners — plus a storehouse of fastening know-how. Call him for unbeatable service or write the factory direct for engineering information.

Allen 'pressur-formd' cap screws are standard stock items in sizes from No. 4 thru 1 in. Flat head cap screws, No. 4 thru ¾ in. Both N. C. threads. Many sizes are also standard in stainless steel, or in Allenoy steel with N. F. threads.

FOR SCUFF-RESISTANT BEAUTY. This Sunroc water cooler has, as standard equipment, a Stainless Steel kick plate for protection against scuffing and corrosion when floors are mopped. The deep drawn top is also made from Stainless. It's bright and inviting, and easy to clean.



FOR LONG, HARD SERVICE. Some of the Stainless Steel tubes in this bundle are 20 years old, despite the fact that they have been in continual service in a thermal cracking unit at a major southwestern oil refinery. Even though some of them have been lengthened by heliarc welding, they still retain their ability to handle corrosive products.

NOTHING *can equal* *Stainless Steel*

FOR SANITATION. This is a Stainless Steel rotary washer at a baby food plant of Gerber Products Company. Stainless Steel was used because of its great corrosion resistance, because it will not contaminate the food products, because it is so very easy to clean. Gerber's uses a lot of Stainless Steel processing equipment—including peelers, bins, steamers, holding tanks and filling machines.

• No other design material can match Stainless Steel in its *combination* of desirable properties: corrosion resistance, strength and hardness, beauty, cleanability and easy fabrication. When seeking a source of supply, remember that United States Steel offers the widest range of types, finishes and sizes available in the United States.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

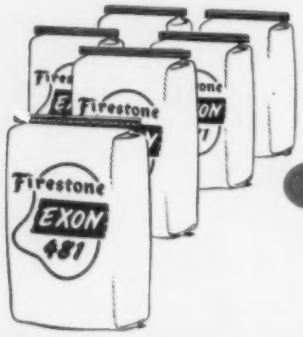
USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS
PIPE · TUBES · WIRE · SPECIAL SECTIONS

USS

UNITED STATES STEEL

EXON: each resin engineered for a specific problem



EXON 481

specifically for

CONSTRUCTION COATINGS

Site application of colorful, abrasion-proof coatings that last is now possible with the development of EXON 481 resin.

Simply sprayed on by a gun with 60 lbs. pressure over a prime coat, the stainproof, scuffproof sheeting dries the instant it is applied. Application is so quick and easy that the most complex shapes are no problem. No loose ends, seams, laps or joints.

EXON 481 has exceptional tensile strength — over 1000 lbs. per square inch with an elongation factor up to 200%. It is soluble in ketones, compatible with plasticizers, stabilizers and all pigment types.

As a result, coatings of the most decorative, attractive colors can be formulated. All completely washable, they ruggedly resist fading or cracking.

Firestone

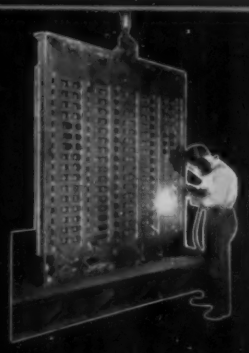
EXON

For complete information or technical service on EXON *481 and on all the resins in the ever-growing* EXON *line, call or write:*

CHEMICAL SALES DIVISION

FIRESTONE PLASTICS COMPANY, DEPT. 66C, POTTSTOWN, PA.

DIVISION OF FIRESTONE TIRE & RUBBER CO.



WELDING SOLVES ANOTHER WEIGHT PROBLEM

(and USS "T-1" Steel solves the welding problem!)

Bedplates for modern color-printing presses have to be rugged—but as lightweight as possible. They must withstand constant pounding from printing rollers and cutting knives. And, since they move back and forth continually, they've got to be lightweight for fast, efficient operation. It is a good place to use a welded assembly of steel plate.

But that's where Graver Tank & Manufacturing Co., Inc., ran head-on into a tough fabrication problem. Alloy steel with the necessary strength and durability was difficult to weld. And with 534 welds to make on *every* bedplate, this was a king-size headache.

NO MORE HEADACHE!

Now the headache is gone. Production costs are down. And the finished bedplates are working hard and long . . . taking a tremendous daily pounding without distortion.

The solution? Just a switch to a remarkable *new* alloy steel, USS "T-1" Steel.

"'T-1' Steel is very strong. Very tough. Able to take vicious impact abuse. Yet, it's easy to weld," says Mr. H. McDonald, Superintendent at Graver.

HOW ABOUT YOU?

If you have tough jobs, rugged jobs, where you want to weld your way to lower costs, give this new steel a try. We think you, like Mr. McDonald, will find it the best thing you have ever used. Right now, "T-1" is in service and doing well in bridges, power shovels, steam turbines, electrical transformer tanks, flywheels, pressure vessels, mine cars, and lots of other places. Write for details. United States Steel, Room 5088, Pittsburgh 30, Pa.

"TOP QUALITY" That's how Graver Tank & Manufacturing Co., Inc., East Chicago, Indiana, describes new USS "T-1" Steel. It gives them a yield strength of 90,000 psi . . . exceptional resistance to impact abuse . . . and good weldability. It enables them to build extremely rugged, all-welded bedplates for printing presses.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

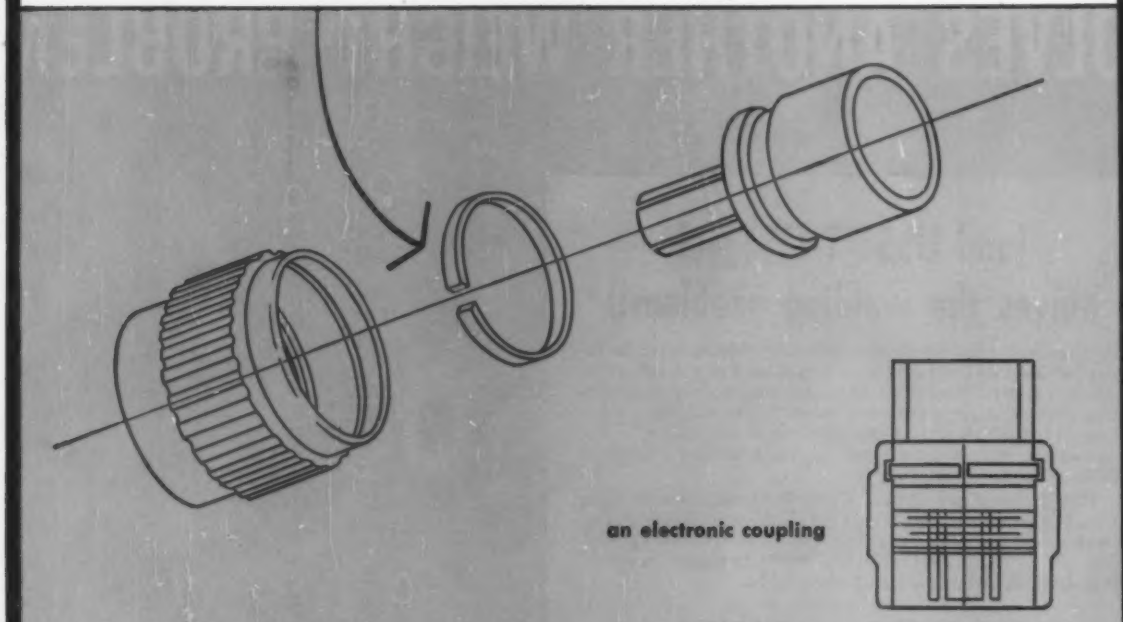
USS "T1" CONSTRUCTIONAL ALLOY STEEL

USS

6-15

UNITED STATES STEEL

REDESIGN TO SAVE TIME AND MATERIAL



Examine the designs of *all* of your products and machines. No doubt you can use retaining rings on axles and in housings—*not only to save assembly time, but to save weight, parts and space.*

Many manufacturers have not only increased their profits but have also improved their products by using these high-grade rings, fabricated in various metals. Their uses are varied—ranging from heavy-duty engines and drill presses to toys, gadgets and small parts of articles made of metal, wood or plaster.

Don't pass up opportunities to increase your profits; let our engineers consult with you.

THE NATIONAL LOCK WASHER CO.

NEWARK 5, NEW JERSEY — MILWAUKEE 2, WISCONSIN

Here's one reason why Michigan Tractor Shovels can move more yards per day, day after day . . .

USS MAN-TEN Steel provides extra strength and toughness in bucket and bucket boom

DESCRIBED AS "a bear for punishment and a hound for work" this big-yardage earth mover built by Clark Equipment Co., Construction Machinery Division, of Benton Harbor, Mich., is so engineered that every part contributes to high capacity operation and continuous, long-time service.

Use of USS MAN-TEN High Strength Steel in both bucket and bucket boom is typical of the care taken to ensure maximum durability and freedom from breakdown.

USS MAN-TEN Steel with a yield point of 50,000 psi—one and a half times that of ordinary carbon steel—readily provides the stamina needed to handle full buckets hour after hour. Its 40% higher fatigue strength safely absorbs shock and vibration when working the shovel into heavy, hard-to-dig material. Its greater abrasion resistance pays off in materially reducing bucket wear.

All these benefits inherent in USS MAN-TEN Steel combine to promote more dependable and more efficient shovel performance. They are obtained with no increase in weight, at little or no increase in cost.

Contact our nearest office and let us show you how you can apply USS MAN-TEN or our other High Strength Steels—USS COR-TEN and USS TRI-TEN—in place of carbon steel, to make your equipment *better*—able to do more work—able to last longer—with fewer stops for service and maintenance.

TO HELP YOU—Our "Design Manual for High Strength Steels" contains comprehensive and practical information that you will find extremely useful in designing your product for greater efficiency and economy by the sound use of high strength steels. For your free copy, write on your company letterhead, giving title or department, to United States Steel Corporation, Room 5131, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS MAN-TEN High Strength STEEL

USS

6-296

UNITED STATES STEEL

There's **MORE** Cooling Surface in these deep-ribbed **MOTORS**

No Day is FRYDAY

with these Allis-Chalmers MOTORS

● Frying of insulation is impossible under normal conditions with the extra-large cooling surface of Allis-Chalmers rib-type TEFC motors. The result — you expect and get longer motor life.

The engineered partner of A-C motors is Allis-Chalmers control.

Get Complete Information

As a new machinery component or as replacement, specify Allis-Chalmers. Discuss your particular application with your nearby A-C distributor, A-C district office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-4881

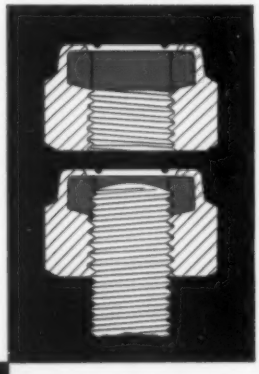
What's special about this STOP NUT?

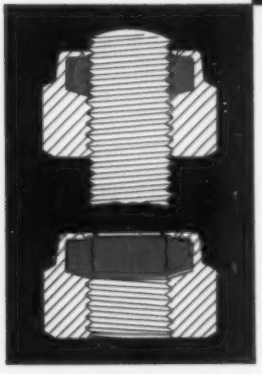
Several things make this nut unusual. For instance, you can "stop" it at any position on the threaded length of the bolt . . . or wrench it tight against the work where it protects bolt threads against corrosion and prevents liquid leakage. No matter where you leave it on the bolt, it will remain tight in that exact position, even though you subject it to heavy vibration and shock loads. But use a wrench on it and it comes off as easily as it went on. The red locking collar is nondestructive—does not gall bolt threads or remove plating. You can remove it and re-use it again and again.

What gives it its grip?

1 The locking collar is unthreaded and elastic. It has an inside diameter smaller than the major diameter of standard bolts.

2 The bolt impresses a mating thread into the collar and the resulting compressive forces exert a constant friction grip on the bolt. . . .





3 and exert a downward thrust bringing the lower flanks of the bolt thread into firm metal to metal contact with the matching nut threads, eliminating normal axial play.

4 Nut is removable and reusable . . . the Red Elastic Collar retains its grip after repeated usage.

Will it hold under ALL conditions?

The locking principle of the Elastic Stop® nut has been tested and proved by over 25 years of actual field service. Elastic Stop nuts are used on locomotives . . . and pile drivers. They fasten hedge shears and harvesters, drilling rigs and washing machines, trucks and roller skates. And no Elastic Stop nut customer has ever stopped using them because of unsatisfactory performance.

What about sizes and materials?

Elastic Stop nuts are available from a watchmaker's 0-80 all the way to 4"—in materials that include stainless steel, brass, aluminum and other alloys. Protect your product with "fastener insurance." Try Elastic Stop nuts on trouble spots, whether to protect expensive heavy equipment from costly downtime or to guarantee the accuracy of delicate electrical equipment by maintaining precision adjustments. We'll supply free test samples.

ESNA® TRADE MARK

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. N82-12, 2330 Vauxhall Road, Union, N. J.

Please send the following free fastening information:

☐ ELASTIC STOP nut bulletin

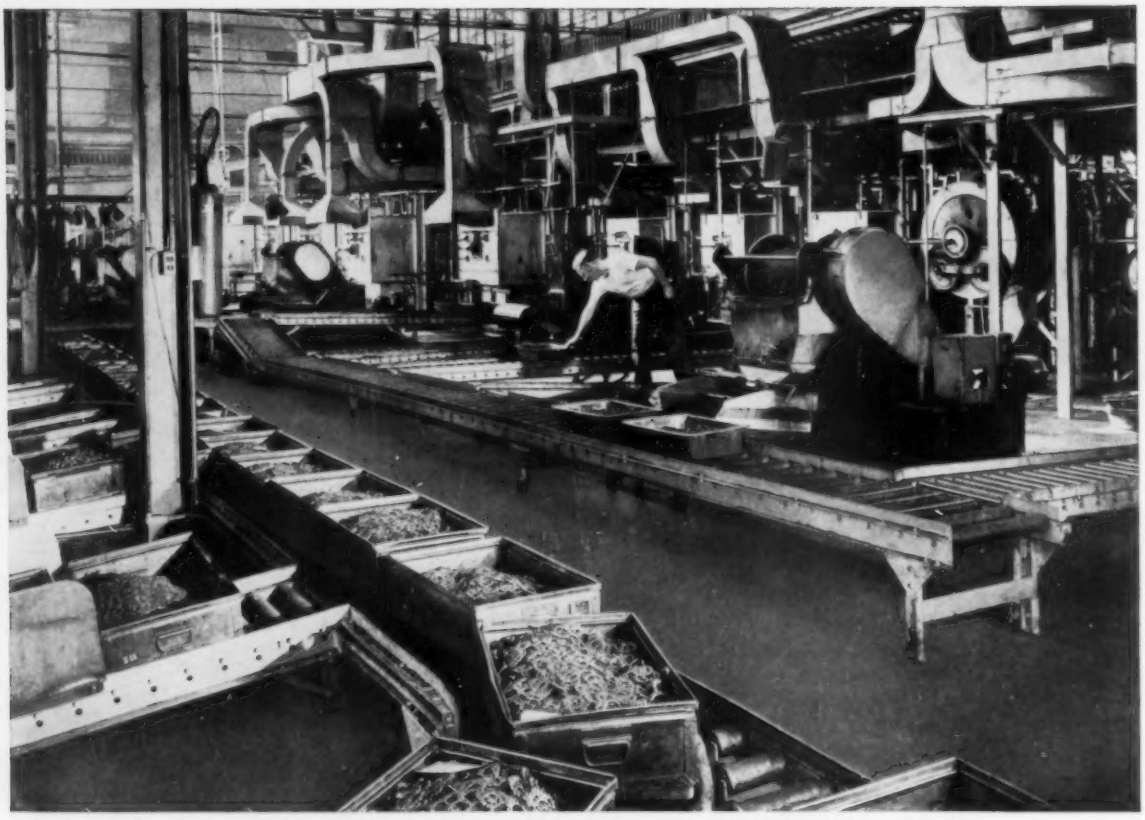
☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name _____ Title _____

Firm _____

Street _____

City _____ Zone _____ State _____



At low heat-hour cost . . . Nichrome muffles give thousands of hours of high temperature service in gas furnaces manufactured by the American Gas Furnaces Company, Elizabeth, N. J., in operation at plant of Shakeproof Div., Illinois Tool Works, Elgin, Ill.

Nichrome muffle . . . able to handle corrosive gas for 5½ years at 1600°F

HANDLING A CORROSIVE MIXTURE of city gas and ammonia, a Nichrome muffle used for heat treating small steel parts completed 36,732 hours of almost uninterrupted service at 1600°F.

But this temperature is no severe test for Nichrome. Even at higher temperatures, under normal heating conditions you'll find little deterioration of this 60% nickel-15% chromium-iron alloy.

Actually, the big story about a Nichrome muffle is its ability to withstand "thermal shock." Shock from repeated alternate heating and cooling. And shock from intermittent charging of cold work.

Naturally, the 60% nickel content in Nichrome produces significant effects. For one thing, it improves load-carrying characteristics at elevated temperatures. Equally important, the nickel addition plays a major role in improving resistance to scaling from common industrial atmospheres.

A typical Nichrome* muffle, produced by Driver-Harris Co., Harrison, N. J. Nichrome muffles of this type weigh from 291 to 2775 lbs., depending on furnace size and function.

*Reg. Trademark of Driver-Harris Co.

That's why you find Nichrome muffles, retorts and other heat treating components used extensively for nitriding, for carburizing, for oxidation . . . for handling reducing gases, and for operations involving high temperature fatigue.

If you have a metal problem, we'll be glad to help with our wide practical experience. No matter what your industry, send the details of your difficulty for our suggestions. Write us now.

INCO TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N. Y.

• Cleveland OOD double reduction type speed reducer installed on a Micregrinder. Photo courtesy Curtin-Herbert Co., Inc., Gloversville, N. Y.

CLEVELAND-driven grinder sands to .001"

THIS highly accurate Micrognder is used to sand wide webbed material to extremely close tolerances. In some production jobs it sands to plus or minus .0005". Such precision work demands dependable, uniform power transmission—and a Cleveland double reduction worm gear speed reducer has a vital part of the job.

The abrasive-wrapped cylinder is driven by a 20 hp motor. A belt drive runs from the cylinder to the Cleveland speed reducer, and the back-up roll is chain driven from the reducer. The extended intermediate shaft drives a ball bearing eccentric which oscillates the cylinder.

Clevelands fit perfectly into complex power transmission jobs. They're compact—right angle construction of a worm gear drive saves space. High shock load resistance and efficient performance are inherent. Parts are reduced to a minimum, reducing maintenance. Torque flow is smooth and uninterrupted. The case-hardened steel worm and nickel-bronze gear actually improve with use.

Wherever you have a power transmission need or problem, simple or complex, find out how a Cleveland speed reducer can handle it dependably and economically. Send for Catalog 400 today. The Cleveland Worm and Gear Company, 3279 East 80th Street, Cleveland 4, Ohio.

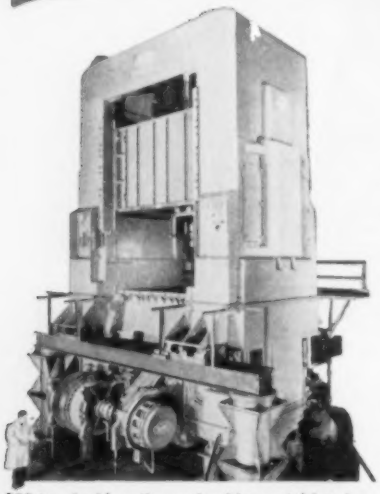
Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

EATON

DYNAMATIC®

EDDY-CURRENT EQUIPMENT

is Solving Speed Control Problems in Every Major Industry



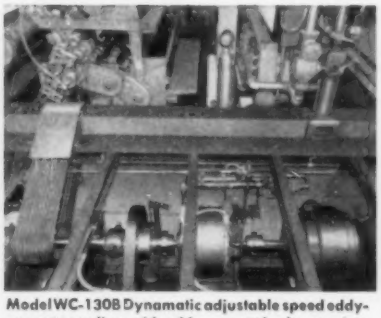
800 ton double-action under-drive metal forming press, driven by Dynamatic model 37-32 combination eddy-current coupling and brake.

In practically all testing, processing, and conveying equipment common to industry, Dynamatic eddy-current rotating equipment is solving a wide range of adjustable speed drive problems, particularly where an AC power source is a requirement.

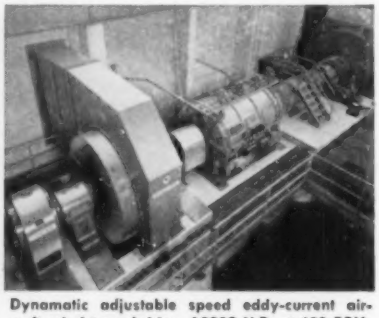
Advantages include rapid response, stepless adjustable speed control, wide speed range, quiet operation, low power loss, low maintenance cost, adjustable speed from an AC power source.

Send for Bulletin GB2, which describes and illustrates the basic Dynamatic eddy-current units, including couplings, brakes, dynamometers, press drives, and Ajusto-Spede® drives.

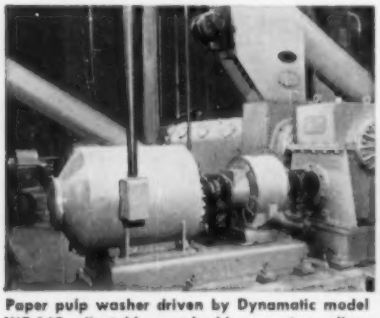
Tandem Dynamatic dynamometers, rated 20000 H.P., 600 to 5800 RPM. A cradled gear box permits turbine testing to 15000 RPM.



Model WC-1308 Dynamatic adjustable speed eddy-current coupling with eddy-current brake, used as printing press drive. Rated 20 H.P at 1700 RPM.

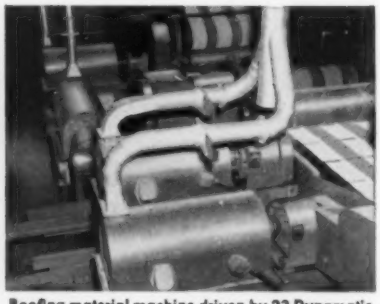


Dynamatic adjustable speed eddy-current aircraft wind tunnel drive, 18000 H.P. at 480 RPM.



Paper pulp washer driven by Dynamatic model WC-160 adjustable speed eddy-current coupling, rated 125 H.P. at 1100 RPM.

Dynamatic model WC-160 adjustable speed eddy-current coupling, rated 100 H.P. at 1100 RPM, used as cement kiln drive.



Roofing material machine driven by 23 Dynamatic Ajusto-Spede® drives. All drives and controls completely enclosed and force ventilated.

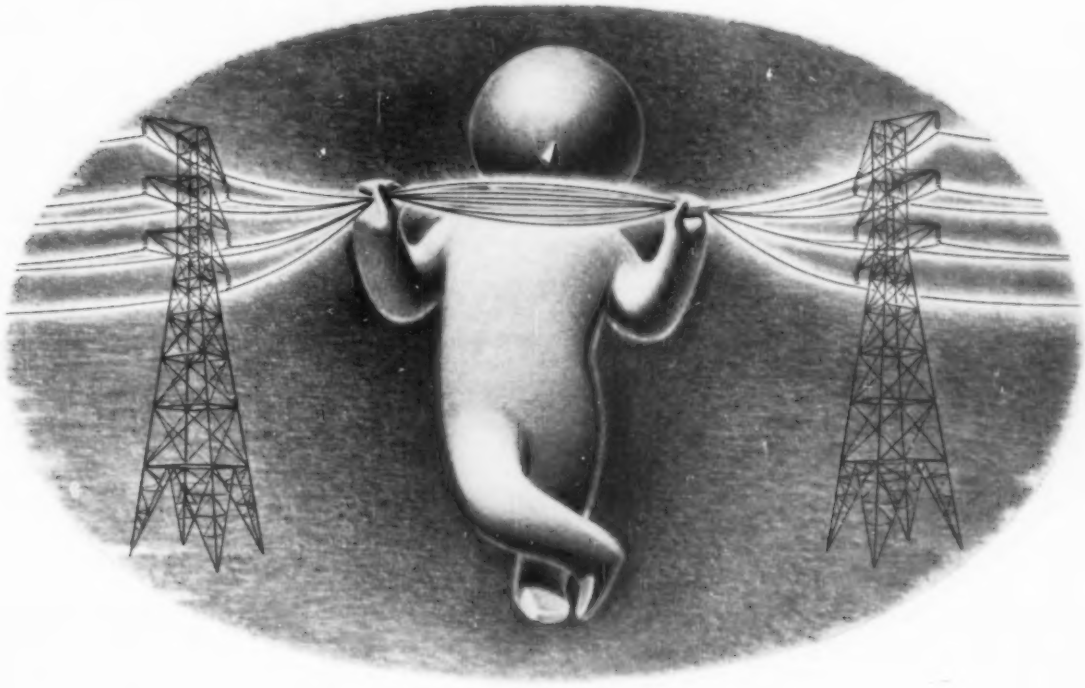
EATON MANUFACTURING COMPANY — DYNAMATIC DIVISION

3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

How can you benefit from the amazing

ELECTRICAL PROPERTIES

of G-E silicone rubber AT HIGH TEMPERATURES?

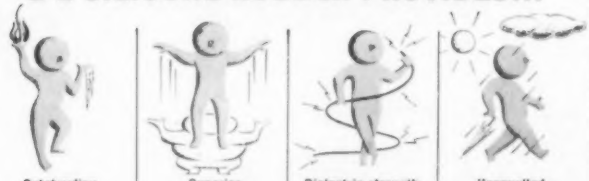


Amazing electrical properties at high temperatures are among the outstanding characteristics of General Electric silicone rubber. It is ideal for wire and cable insulation where overloads or space limitations dictate a heat-resistant dielectric. Cables have been redesigned with G-E silicone rubber to carry nearly *twice the current—with no increase in size!* G-E silicone rubber not only provides Class H insulation, but can be used to improve Class B insulation as well.

Where can YOU use G-E silicone rubber? There's a kind for almost every requirement, classified according to dominant property for easy selection and specification. For example: Class 300 offers the best recovery after compression *of any known rubber!* Class 500 provides flexibility *at 130°F below zero!* Which class is best for *you?*

SEND FOR A FREE "LIGHTNING SELECTOR"—TODAY!

G-E SILICONE RUBBER PROVIDES...



Outstanding resistance to extreme temperatures

Superior resistance to compression set

Dielectric strength stable at high temperatures

Unequalled resistance to aging, ozone, weathering

Silicone Products Department
General Electric Company
Section 63-1D
Waterford, New York

Please send me technical data on G-E silicone rubber, including a free "Lightning Selector" and up-to-date list of fabricators.

Name_____ Position_____

Firm_____

Street_____

City_____ Zone___ State_____

IN CANADA: Mail to Canadian General Electric Company, Ltd., Toronto

G-E silicones fit in your future

GENERAL ELECTRIC

(*Advertisement*)

Riveting With a Hammer in Blind or Open Applications

Elimination of special riveting tools can mean faster production, lower costs, no down time.

J. K. BARRY, M. E.

The use of blind rivets installed with only an ordinary hammer from one side of the job offers a highly simplified method of fastening. Speed, convenience and *low installed cost* make Drive Riveting preferable not only for blind joints, but for fastening many parts that can be reached from either side.

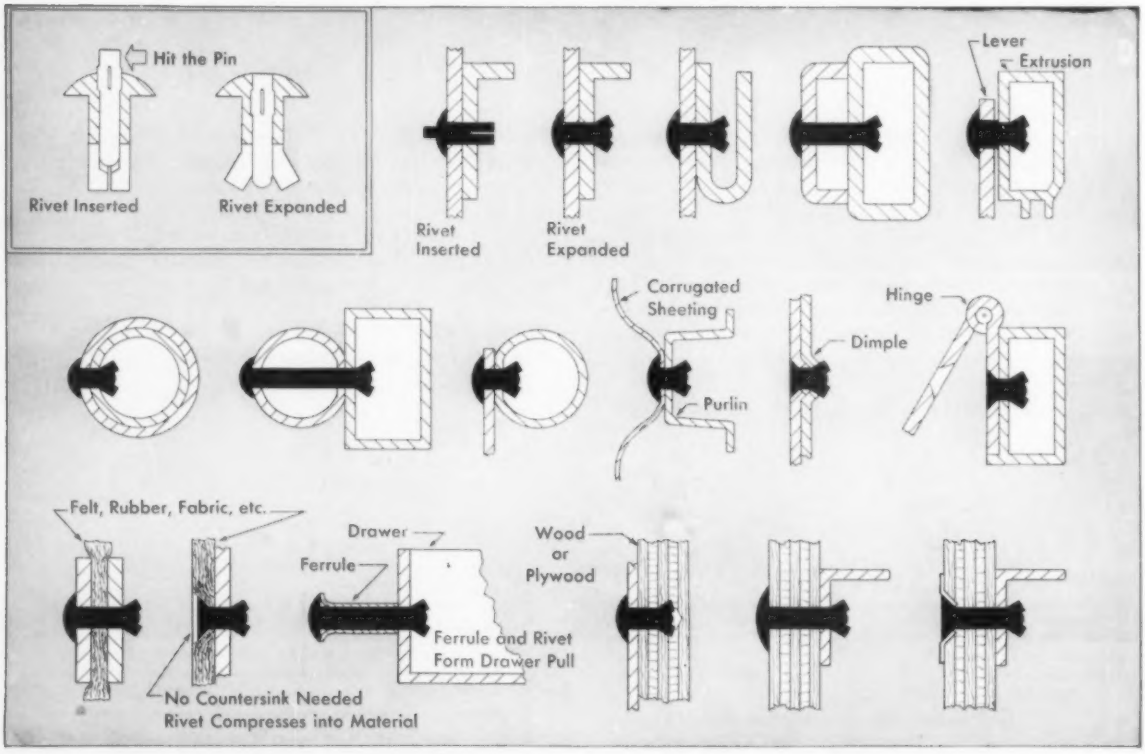
The Southco Drive Rivet has a cored, slotted body with a grooved pin protruding from its head. When the rivet is inserted through parts to be fastened, the pin is driven flush with the rivet head causing the expanding prongs to form a blind head behind the rear sheet. No further finishing is necessary, since the pin seats itself permanently to complete the smooth head contour.

Drive Riveting has five major advantages:

1. No investment in special tooling.
2. No lost time for tool repairs.
3. No limitation on the number of men who can install rivets.
4. Speed comparable to nailing.
5. Only one man is needed.

Widely used in truck bodies, storm doors, metal buildings and hundreds of other industrial applications, Southco Drive Rivets make a secure, vibration-proof joint. A wide range of head styles, diameters and grip lengths is available.

RECOMMENDED APPLICATIONS FOR DRIVE RIVETING



SOUTHCO Division, South Chester Corporation, 236 Industrial Hwy., Lester, Pa.

WHEN the problem is a rush hollow parts job, phone or wire the Timken Company and we'll ship less-than-mill quantities of 52100 tubing within 24 hours after receiving your order.

Timken® 52100 steel tubing is excellent for most of your high quality hollow parts jobs. It's a through-hardening steel in moderate sections. It can be heat treated to file hardness and tempered back to any desired point. And it can frequently be used in place of more expensive steels.

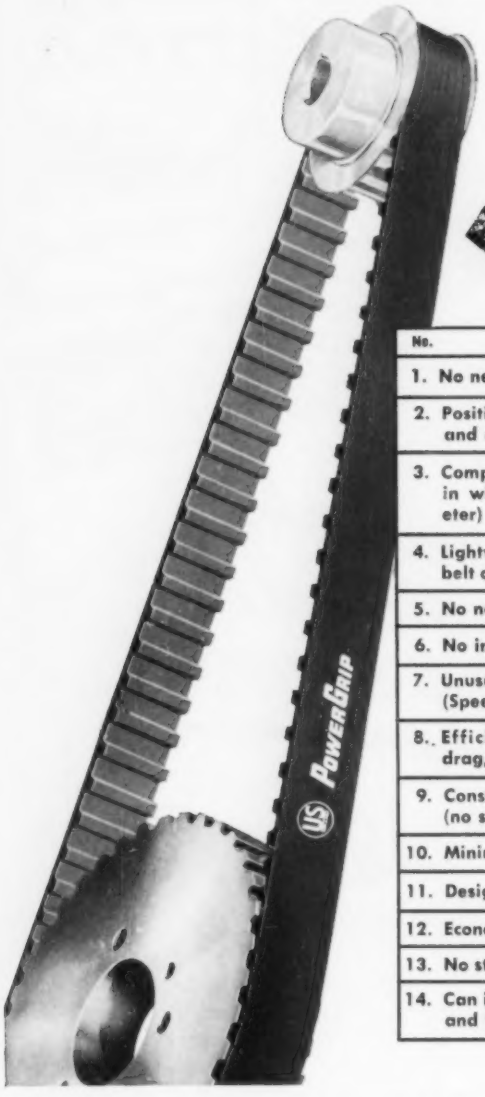
Available in sizes from 1" to 10½" O.D., Timken 52100 steel is used for hollow parts such as: aircraft parts, ball bearing races, pump parts and plungers, collets, bushings, spindles, grinding machine parts, precision instruments, and dozens of others.

The Timken Company is America's pioneer producer of 52100 tubing. And we're the only company that makes 52100 steel in tubing, bars and wire. Our unequalled experience assures you of uniform quality from tube to tube and heat to heat.

For immediate delivery of your less-than-mill quantity orders, write, wire or phone The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING



"√" in your transmission belt needs

No. Advantages	PowerGrip "Timing" Belt	Chain	Gear	V-Belts	Flat Belts
1. No need for lubrication	√				
2. Positive elimination of slip and creep	√				
3. Completely compact (Both in width and pulley diameter)	√				
4. Lightweight (Heavy duty belt only 0.1 lb./ft./in.)	√				
5. No noise or vibration	√				
6. No initial tension	√				
7. Unusual speed range (Speeds up to 12,000 FPM)	√				
8. Efficient (Elim. heat, lube drag, high bearing loads)	√				
9. Constant angular velocity (no speed fluctuation)	√				
10. Minimum backlash	√				
11. Design flexibility	√				
12. Economical	√				
13. No stretch	√				
14. Can it be completely housed and forgotten?	√				

Note that the U. S. PowerGrip "Timing" Belt takes a "√" after every advantage

While every type of drive has certain advantages, *no* type of power transmission possesses *so many* advantages as the U.S. PowerGrip "Timing" Belt drive. For example, *it is the only positive drive that never needs lubrication.*

THE LIST OF USES GROWS DAY BY DAY! Power production machinery in every field is made more efficient, volume of production increased, and maintenance costs lowered with this amazing belt. The list of OEM applications grows too numerous to mention. U.S. PowerGrip has streamlined hundreds of products... made them sell above competition. Some equipment would not be in existence at all, if it weren't for this great belt.

Immediate delivery of stock drives with ratios up to 12 to 1 is obtainable from any of United States Rubber Company's selected distributors, any of the 27 "U. S." District Sales Offices, or by writing us at Rockefeller Center, New York 20, N. Y.

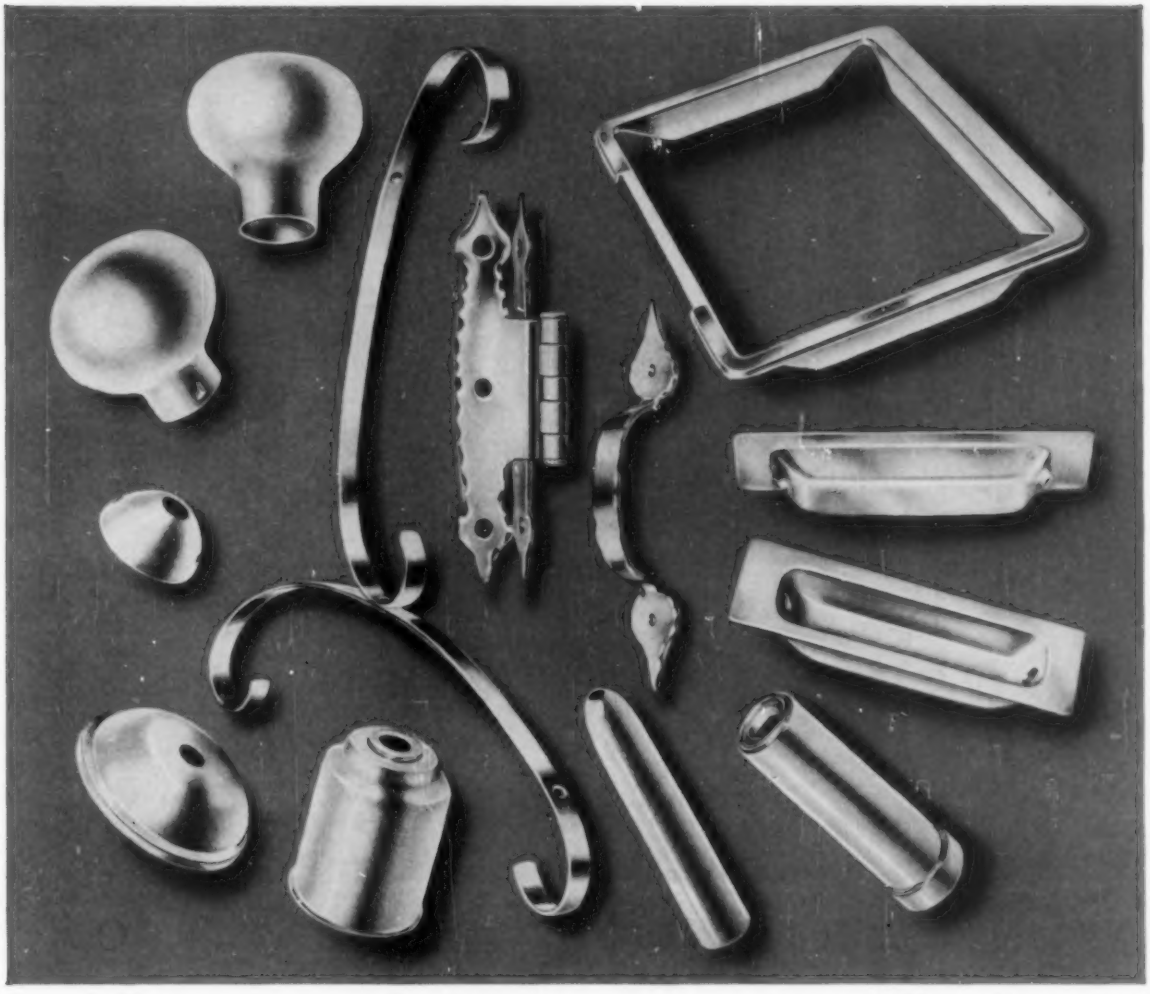
Send for free illustrated manual, complete with standard drive tables.

US RUBBER

Mechanical Goods Division

United States Rubber

A SHORT CUT TO A FINISHED PRODUCT



CUT POLISHING COSTS IN HALF WITH Formbrite

the new superfine-grain drawing brass with the built-in finish

The secret is in the grain: Special methods of rolling and annealing produce in Formbrite* a grain structure so fine that often a simple color buff will bring it to a bright, lustrous finish.

Formbrite is also harder, stiffer, springier and more scratch resistant—yet it is surprisingly ductile, readily stamped, formed, drawn, and embossed. And Formbrite plates beautifully.

More and more companies are using Formbrite to cut their polishing costs and get superior products—at no extra cost over ordinary drawing brass. They often save more than the cost of the metal itself.

Globe Lighting Products: Reports savings in polishing cost of from 26% to 55% in various components of their high-quality, solid brass lighting fixtures. Work pile-ups were eliminated in the polishing room, too.

Farrington Mfg. Co.: Rejects after polishing dropped from 11% to under 1% after switch to Formbrite in frames for "jewel-box" case for an electric shaver. A better finish in one faster pass through the automatic polishing machine.

Jarco Metal Products, Inc.: Polishing costs cut 40% in deep-drawn pen, pencil, and lipstick cases. Uniformity of Formbrite eliminated shutdowns for adjustments in long-run production.

Spill-Stop Mfg. Co.: Saved enough in polishing cost to avoid price increases—despite increased labor and material costs. Reports Formbrite fabricates almost as readily as the softest drawing brass . . . uniformity of gage in Formbrite has simplified manufacture.

Find out for yourself how Formbrite can serve you as a short cut—save you money. See your American Brass Company representative. Write for Publication B-39. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5587

*Reg. U. S. Pat. Off.

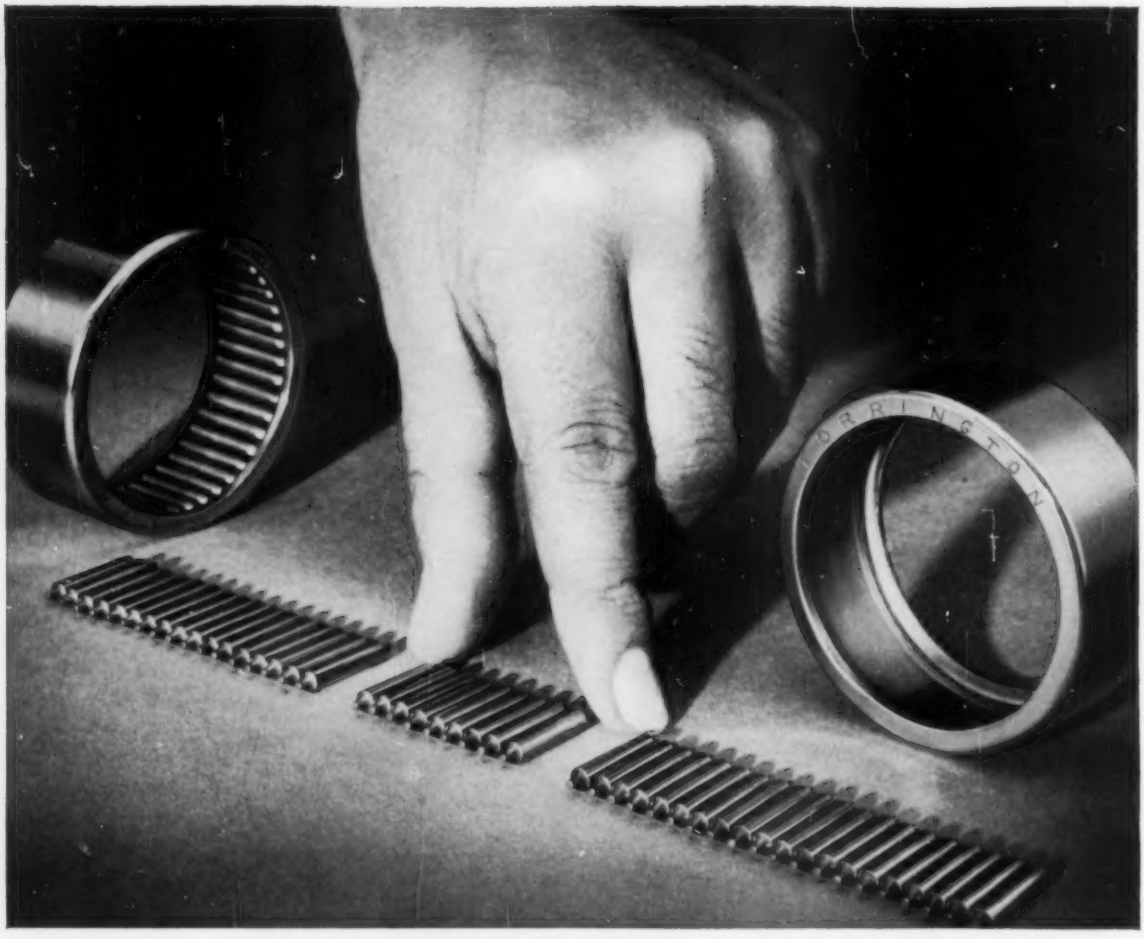
Formbrite

FINE-GRAIN DRAWING BRASS

an ANACONDA® product

made by

The American Brass Company



"Here's where the **TORRINGTON NEEDLE BEARING** *gets its high load capacity"*

The radial load capacity of an anti-friction bearing depends, in the final analysis, on the number of lines or points of contact made by the bearing surfaces in the load zone. This is where the Torrington Needle Bearing really shines.

With its full complement of precision-ground rollers, the Needle Bearing gives many more lines of contact than other types of anti-friction bearings. Thus for a given size, the Needle Bearing has a *greater* radial load capacity than other bearings.

What does this do for your product? The Needle Bearing can give you the benefits of its high-capacity performance for little more than the cost of a plain bearing; it can help you reduce the size and weight of surrounding members without sacrificing shaft strength, thickness or rigidity.

For twenty years, our Engineering Department has helped designers and manufacturers throughout industry to adapt the unique advantages of the Needle Bearing to their products. Let us help you make the Needle Bearing "standard equipment" in yours.

THE TORRINGTON COMPANY
Torrington, Conn. • South Bend 21, Ind.

TORRINGTON NEEDLE BEARINGS
Give you these benefits

- low coefficient of starting and running friction
- full complement of rollers
- unequalled radial load capacity
- low unit cost
- long service life
- compactness and light weight
- runs directly on hardened shafts
- permits use of larger and stiffer shafts

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON BEARINGS

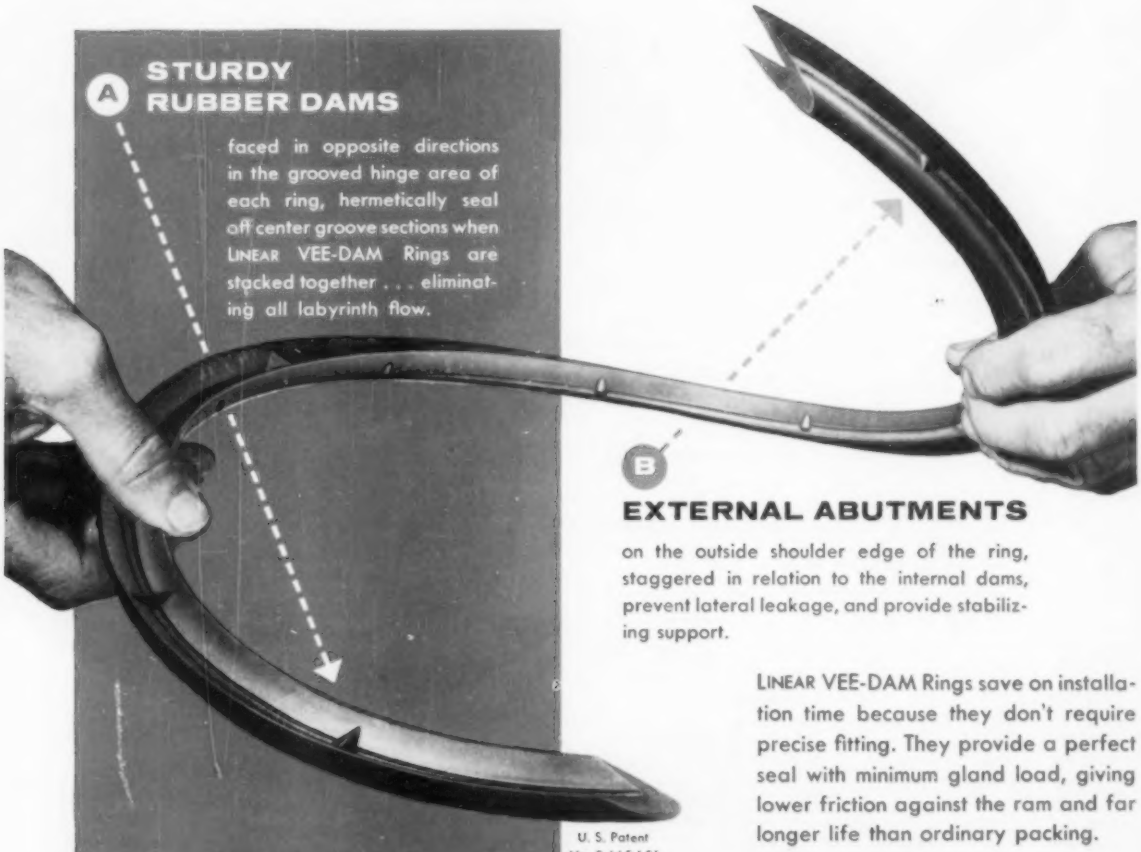
THE TORRINGTON COMPANY 90th ANNIVERSARY 1866–1956

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

At last!
SPLIT V-RING PACKING
that's really LEAKPROOF!

LINEAR VEE-DAM RINGS

Labyrinth flow and lateral leakage are stopped by LINEAR'S uniquely designed, revolutionary VEE-DAM RINGS. Installation of these trouble-saving, long-lasting packings is virtually foolproof!



A STURDY RUBBER DAMS

faced in opposite directions in the grooved hinge area of each ring, hermetically seal off center groove sections when LINEAR VEE-DAM Rings are stacked together . . . eliminating all labyrinth flow.

U. S. Patent No. 2,665,151

B EXTERNAL ABUTMENTS

on the outside shoulder edge of the ring, staggered in relation to the internal dams, prevent lateral leakage, and provide stabilizing support.

LINEAR VEE-DAM Rings save on installation time because they don't require precise fitting. They provide a perfect seal with minimum gland load, giving lower friction against the ram and far longer life than ordinary packing.

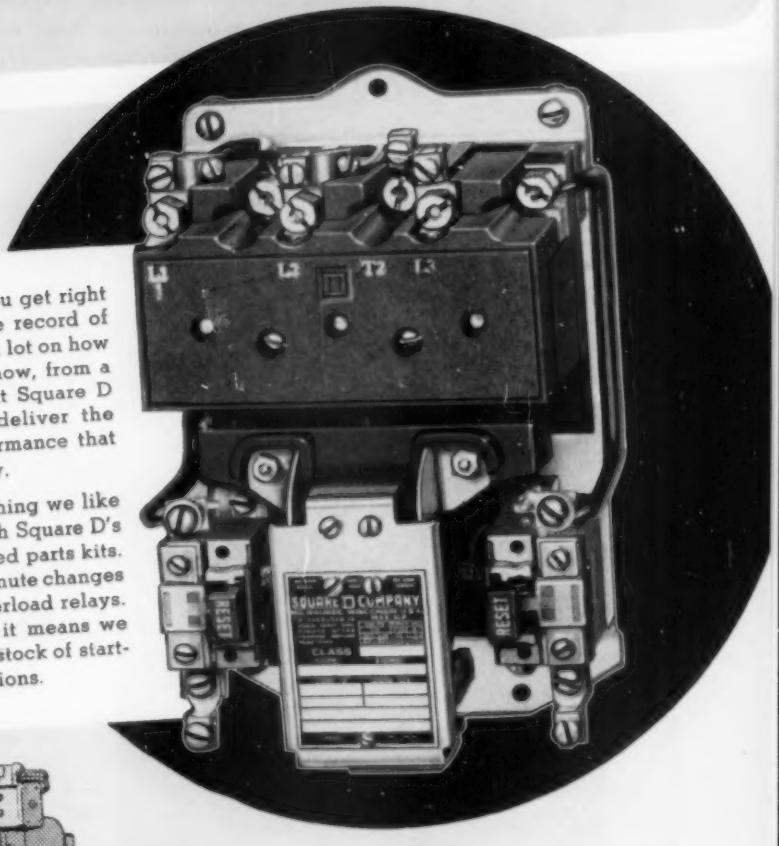
Write or call for complete information on LINEAR VEE-DAM Rings in a choice of rugged, fabric-reinforced synthetic elastomers, tailored to your requirements.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

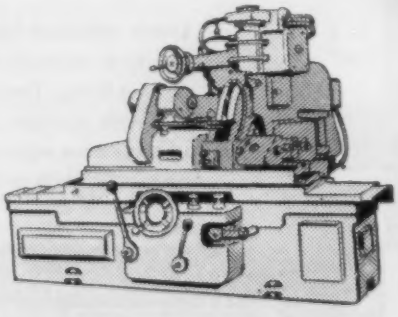
LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

Here's Why We Use SQUARE D Starters on the Machines We BUILD



PERFORMANCE When you get right down to it, the performance record of any machine tool depends a lot on how the control behaves. We know, from a lot of past experience, that Square D starters are designed to deliver the kind of trouble-free performance that keeps our customers happy.

FLEXIBILITY Another thing we like is the flexibility we get with Square D's starter design with packaged parts kits. It's a cinch to make last-minute changes in interlocks, coils and overload relays. That's important because it means we don't have to keep a big stock of starters with a lot of modifications.



FIELD ENGINEERING SERVICE

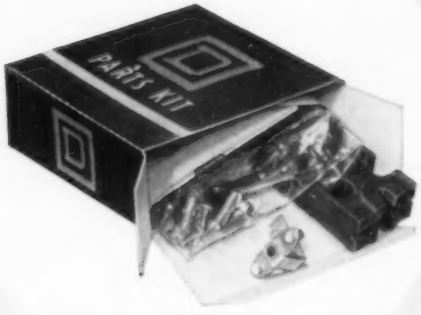
When we're designing machines that call for more complicated electrical control, it's mighty nice to have a Square D Field Engineer handy to work with us. As a matter of fact, he'll carry the ball just as far as we say—even to developing the control circuit for a multi-station machine.

SQUARE D COMPANY

Here's Why We Specify
SQUARE D Starters
on the Machinery We BUY

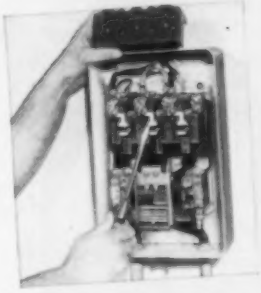
PERFORMANCE, EASY INSPECTION AND MAINTENANCE

Sure, we like Square D performance because it keeps our "down time" at a minimum. BUT—everybody knows that even the best starter needs periodic inspection and preventive maintenance. We like the way Square D makes it easy to handle those routine jobs.

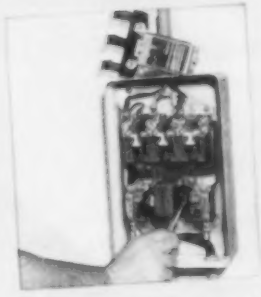


OFF-THE-SHELF PARTS KITS

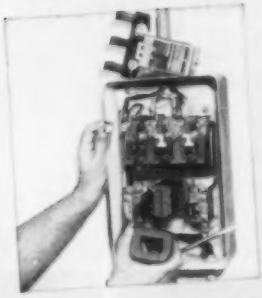
They make normal maintenance and modifications easier than ever. Packaged parts include interlocks, contacts, coils, overload relays, pushbuttons and selector switches. They're easy to buy, easy to identify, and faster to install.



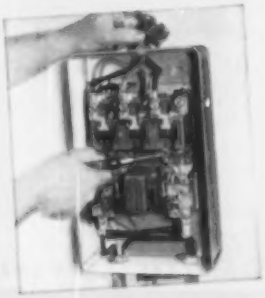
1 Loosen two screws and the arc chamber cover comes off. Every contact surface can be inspected at a glance.



2 Remove four screws and entire movable assembly can be lifted off. Disconnect two wires and slip off magnet coil.



3 Contacts are attached with separate screws—they can be removed and replaced without disturbing any wiring. A screwdriver is the only tool needed.



4 Sizes 0 through 4 starters have these separate mounting electrical interlocks for easier installation. Contact block is attached from front of panel with two screws.

Everybody's Ahead with Square D!

Up to 40% higher tightening torques — a feature of new High-Torque Unbrako socket set screws

RECOMMENDED SOCKET SET SCREW TIGHTENING TORQUES
(Inch-Pounds)

SCREW SIZE	UNBRAKO	SET SCREW B	SET SCREW C	MINIMUM DIFFERENTIAL %
#4	5	3.9	3.5	28
#5	9	7.8	7.4	15
#6	9	7.8	7.4	15
#8	20	14.7	14.5	36
#10	33	26.5	25	25
1/4	87	62	60	40
5/16	165	122	125	32
3/8	290	198	225	29
7/16	430	309	350	23
1/2	620	460	500	24
5/8	1225	1106	1060	11
3/4	2125	1540	1800	18
7/8	5000	3660	4600	9
1	7000	5025	6500	8

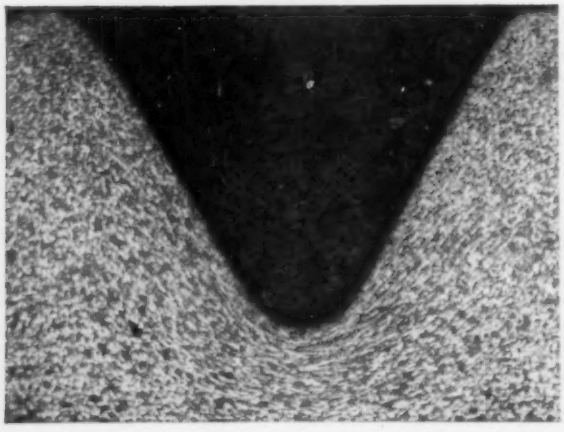
Compare UNBRAKO-recommended tightening torques with those of ordinary socket set screws and you readily see why you can set an UNBRAKO and then forget it. The reasons are simple. UNBRAKOS have deeper sockets, which give you better purchase with the wrench; rounded socket corners, which eliminate the sharp corners where cracks start; fully formed threads, which make them stronger; and knurled cup points, which keep them tight.

Let's see just how the development of fully formed threads make the new High-Torque UNBRAKO stronger. The metal is compressed into the closely knit grain structure that you see in the illustration. The grain flow follows the contour of the threads. There are no straight lines along which shear can occur. An UNBRAKO retains its flow lines even when ground down to .010" below root diameter. Conversely, cut or ground threads have straight flow lines—lose thread form at root diameter.

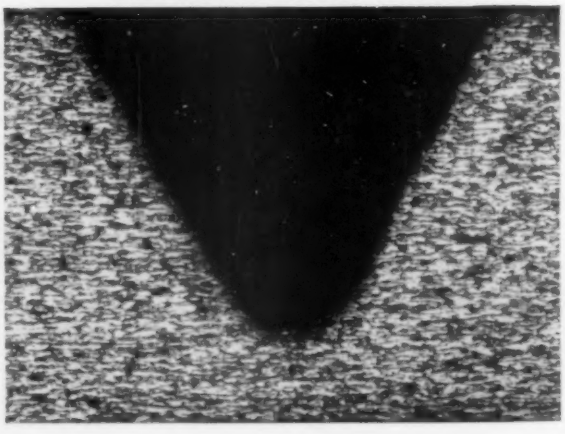
You can't buy a better screw than an UNBRAKO. And you can't get full *high-torque* performance without a "High-Titan" UNBRAKO Hex Key—the high-ductility, precision internal wrenching tool. See your authorized distributor today. Or write STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

STANDARD PRESSED STEEL CO.
UNBRAKO® SOCKET SCREW DIVISION SPS
JENKINTOWN PENNSYLVANIA

UNBRAKO SET SCREW THREADS



ORDINARY SET SCREW THREADS

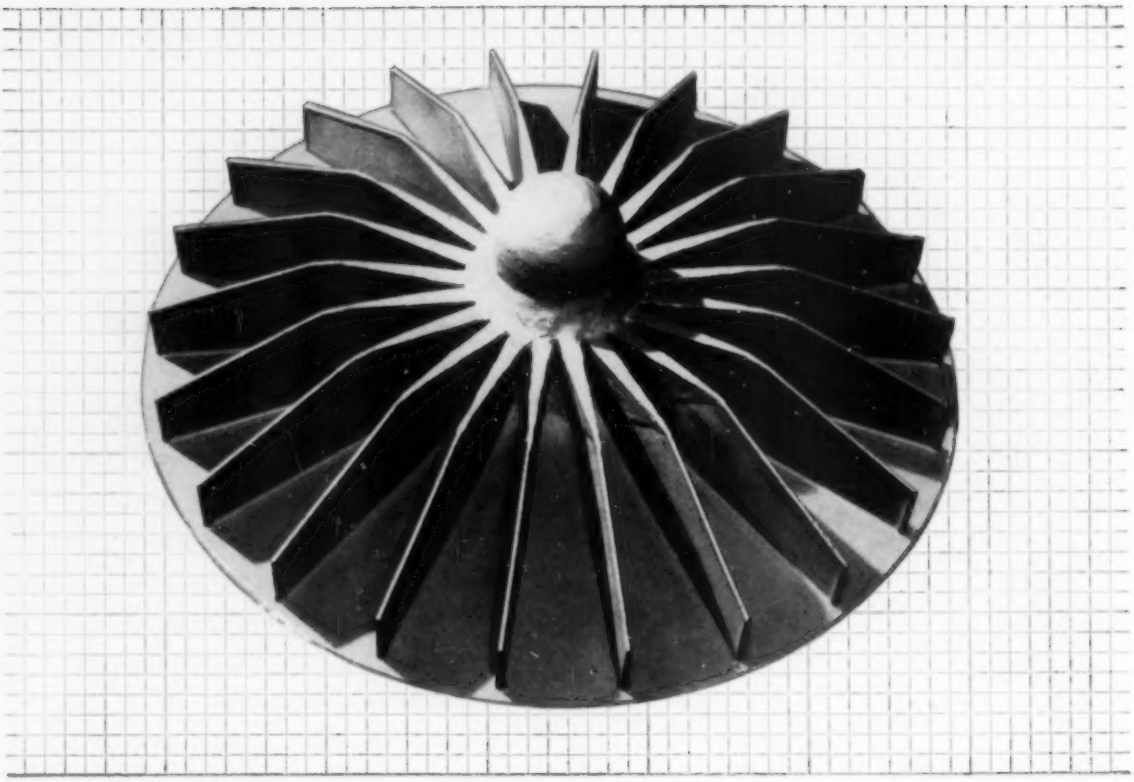


Tied up by tubing problems?

Let Rochester show you the ropes! From design to delivery, Rochester engineers and specialists work with you, assuring top-quality steel tubing and suggesting ways to save you time and money. GM Steel Tubing serves modern industry with top efficiency . . . *and much more economically.* That's why you'll find it on more cars—more refrigerators and freezers—more advanced products every day. GM Steel Tubing is rugged, reliable, flexible, versatile—designed to take it and take any shape. Contact your Rochester Products engineer or write us direct for further information.

GM STEEL TUBING BY ROCHESTER PRODUCTS

ROCHESTER PRODUCTS DIVISION OF GENERAL MOTORS CORPORATION ROCHESTER N.Y.



22-inch Diameter Wheels Investment Cast . . . at a 50% Saving

Turbine wheels, 22 inches in diameter and weighing close to 100 pounds, are now being mass-produced by HAYNES' precision-investment-casting process. The wheels are made of stainless steel and are used in the turbocharger section of a compressor. At one time a lengthy profile machining operation was needed to shape the intricate blades. Investment-casting eliminated this operation and cut production costs in half.

The savings realized on this wheel are typical of the many economies made possible by HAYNES' precision-investment-casting process. This modern mass-production method eliminates many machining, grinding, and assembling operations. Intricate contours, odd-shaped cavities, and thin edges can all be cast to size. Two or more parts can be designed and produced as one integral part. In most instances, an investment-cast part can be placed in operation as soon as it is delivered.

For information on how you can use HAYNES' investment-casting process to keep production costs down, write to any of the District Sales Offices listed below.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

General Offices and Works: Kokomo, Indiana

Sales Offices

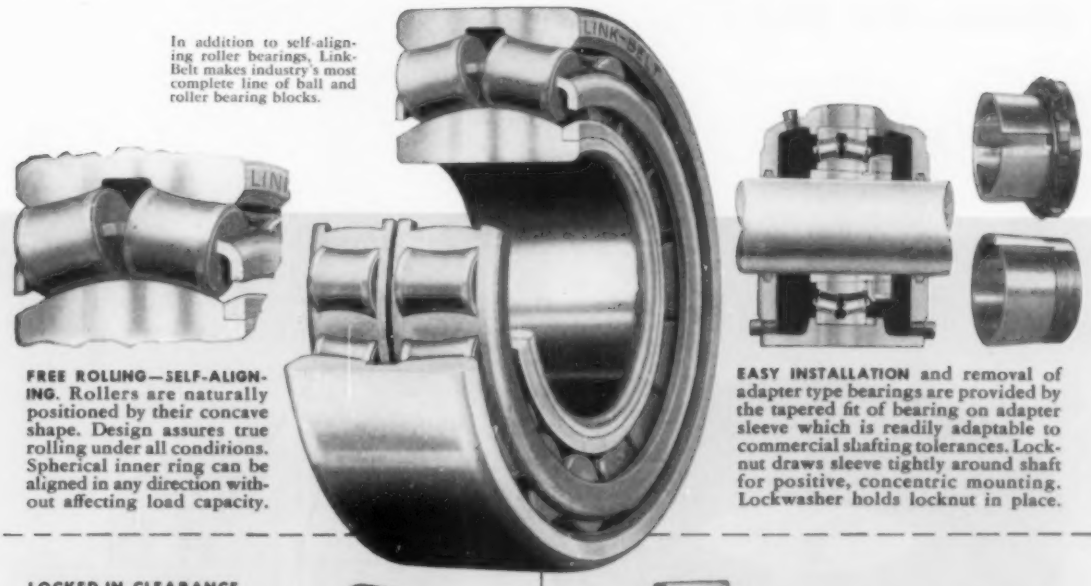
Chicago • Cleveland • Detroit • Houston • Los Angeles • New York • San Francisco • Tulsa

"Haynes" is a registered trade-mark of Union Carbide and Carbon Corporation.

For tough, heavy-duty applications... Make use of these important

bearing differences

In addition to self-aligning roller bearings, Link-Belt makes industry's most complete line of ball and roller bearing blocks.

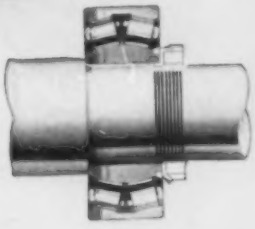


FREE ROLLING—SELF-ALIGNING. Rollers are naturally positioned by their concave shape. Design assures true rolling under all conditions. Spherical inner ring can be aligned in any direction without affecting load capacity.

EASY INSTALLATION and removal of adapter type bearings are provided by the tapered fit of bearing on adapter sleeve which is readily adaptable to commercial shafting tolerances. Locknut draws sleeve tightly around shaft for positive, concentric mounting. Lockwasher holds locknut in place.

LOCKED-IN CLEARANCE. Selective assembly of rollers and raceways with accurately formed hardened steel retainers assures proper operating clearance, guidance and spacing of rollers.

Rollers are completely pocketed in retainers for accurate spacing and guiding.



SMOOTH OPERATION, LONG LIFE are advantages of the straight bore type mounting, which assures maximum concentricity of inner ring with shaft. Especially desirable when minimum radial run-out is essential.

They're all present only in
LINK-BELT self-aligning roller bearings

SUBTLE differences in bearings can make notable differences in the life and efficiency of your equipment. Take Link-Belt self-aligning roller bearings, for example. Their "self-contained" feature permits the bearing to float axially in the mounting, when desired, compensating for shaft expansion or settling of bearing supports . . . preventing extraneous thrust loads from being set up between bearings on the same shaft. What's more, inherent self-aligning design and preadjustment preclude use of expensive or cumbersome self-aligning housings.

Ask your nearest Link-Belt office for Book 2196 on self-aligning roller bearings and Book 2550, containing full data on all Link-Belt ball and roller bearings.

LINK-BELT

Ball and Roller Bearings

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 12,711

GRAPHITAR® HELPS HARNESS

THE POWER OF THE ATOM IN NEW ATOMIC SUBMARINE *NAUTILUS*

GRAPHITAR is a carbon-graphite engineering material that has proved successful in hundreds of difficult applications.

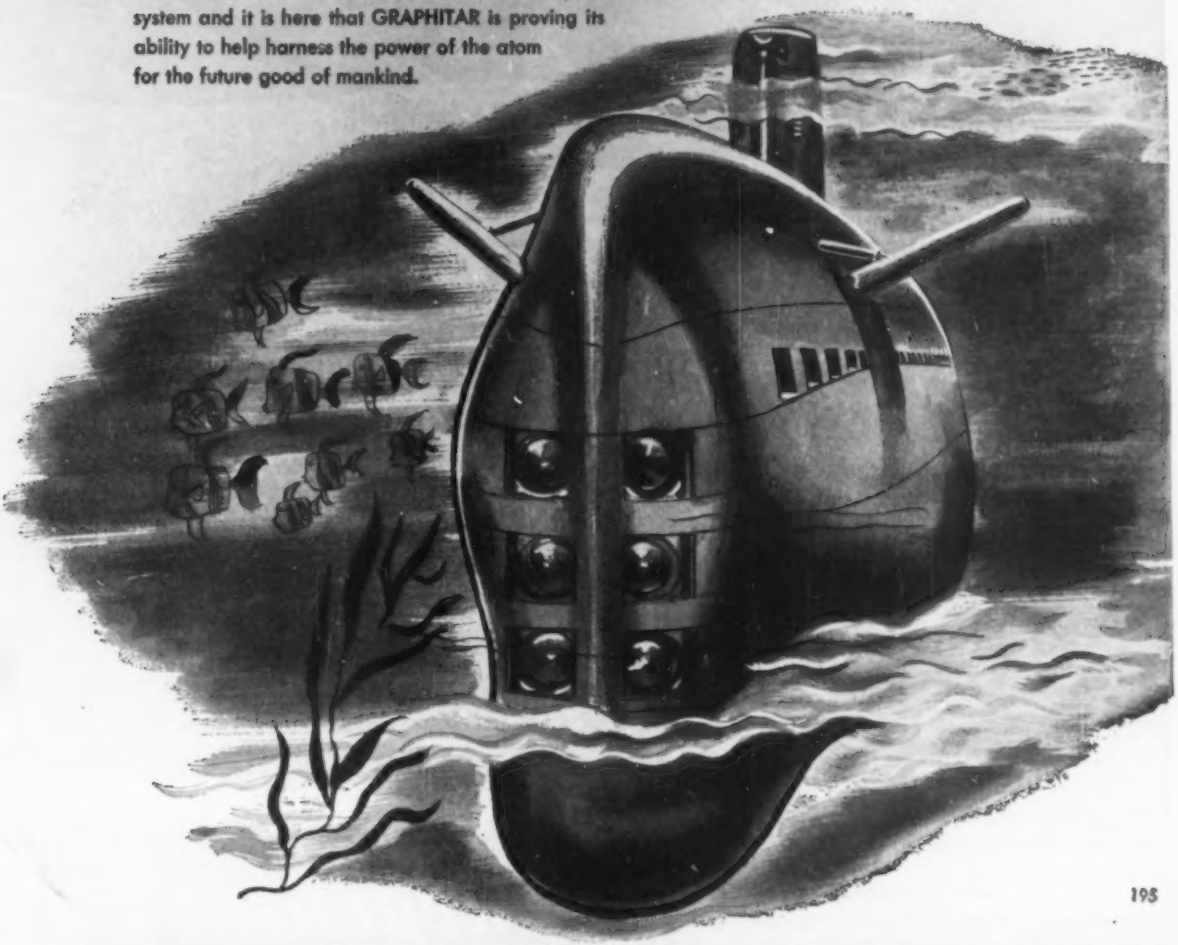
- **GRAPHITAR** can be formed in relatively complicated shapes and ground to tolerances as close as .0005″.
- **GRAPHITAR** is lighter than magnesium and harder than most steels. It is mechanically strong and durable and highly resistant to wear.
- **GRAPHITAR** is practically unaffected by high speeds, high altitudes, high pressures or temperature extremes.

OUR 100th YEAR

THE UNITED STATES

The Westinghouse Electric Corporation, working closely with the Atomic Energy Commission, has designed and built the nuclear power plant for the first atomic-powered submarine, the Nautilus. In atomic power operations, where radioactivity is a difficult problem, fluid systems must usually be hermetically sealed because conventional pumps with external drive motors are not adaptable to this type of operation. For the submarine's power reactor, Westinghouse engineers developed special hermetically sealed pumps with integrated pump and drive motor. The bearings in these pumps, which are made of GRAPHITAR, must withstand high speeds, high temperatures, high pressures and must also operate for indefinite periods of time without maintenance with radioactive hot water as the only lubricant. All leakage past the pump seal is contained within the flooded motor while the purely electrical elements are contained in "cans" to exclude water.

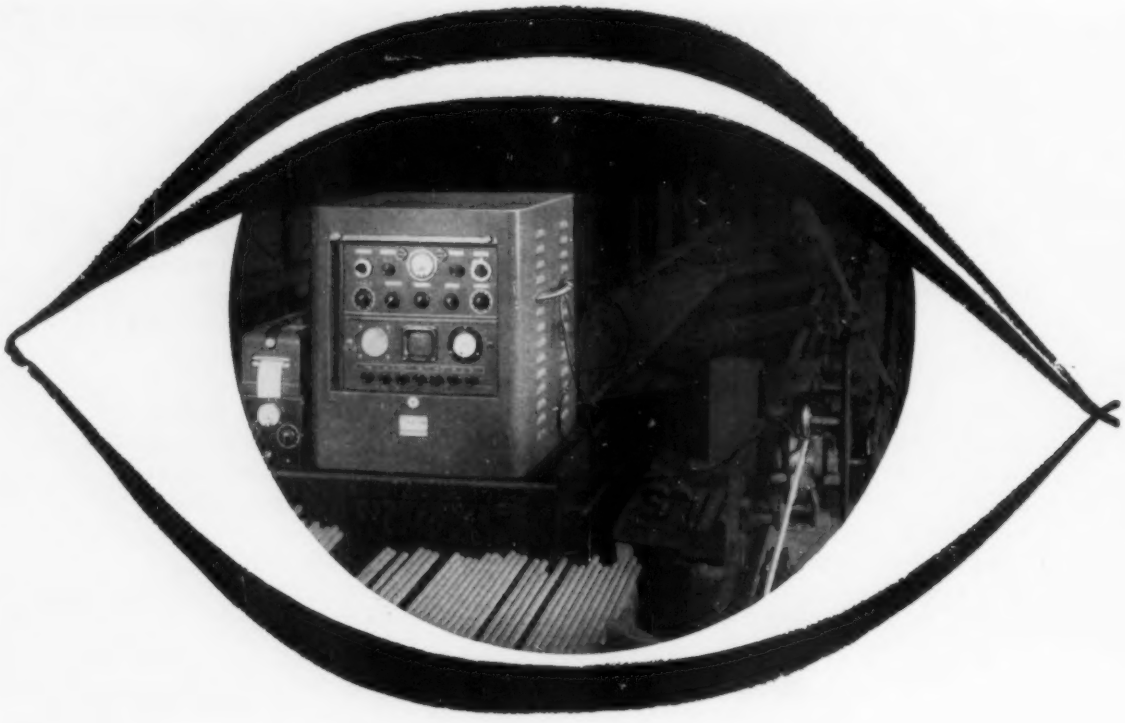
When the Nautilus is put into service, the power to run its conventional steam turbine, which is the actual driving power for the submarine, will come from atomic fires in the reactor where controlled nuclear fission produces enormous amounts of heat. The heat is transferred to the boilers through a closed circuit where the boiler water is turned into steam which is used for driving the turbine. Continuous, trouble-free circulation is extremely vital in this system and it is here that GRAPHITAR is proving its ability to help harness the power of the atom for the future good of mankind.



195

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN



a new "EYE" at *Carpenter*...

GIVES YOU THE HIGHEST DEGREE OF PERFECTION POSSIBLE IN STAINLESS TUBING!

Now, minute tubing defects invisible to the human eye . . . even those not detectable by any other production non-destructive testing method, will not escape the penetrating eye of a new non-destructive test in the Carpenter mill.

It's the most exacting and thorough quality control device ever developed for testing austenitic stainless tubing during production. Flaws that don't show up in hydrostatic tests are brought to light by this new testing device as it critically scans the entire I.D. and O.D. periphery of the tubing. It also detects variations in composition, gauge, sub-surface and surface conditions at production speeds.

What does this newest Carpenter advance mean to you? It means that Carpenter now assures you of better-than-ever quality . . . the highest degree of perfection possible in stainless tubing. It means added assurance for you that Carpenter Stainless Tubing, more than ever, is your best buy for life-long trouble-free service.

Ask your Carpenter Representative or local Carpenter Distributor for more details about this new quality control measure. Specify Non-Destructive Test on your inquiries and orders.

MEMBER

The Carpenter Steel Company,
Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

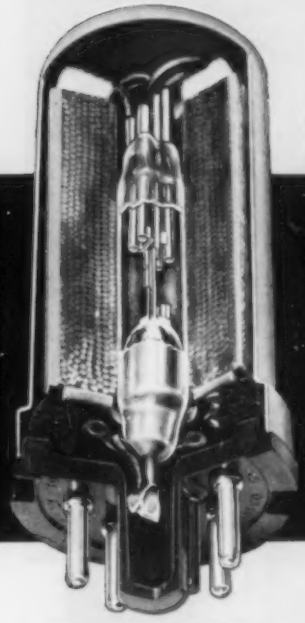
Carpenter

Stainless Tubing & Pipe

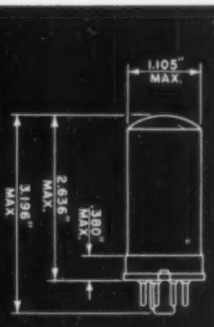
A BILLION OPERATIONS

. . . with no maintenance whatsoever

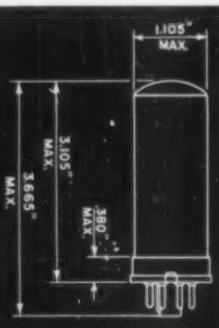
. . . from NEW CLARE Mercury-Wetted Contact Relays



• Cutaway view showing sealed-in-glass, mercury-wetted contact switch, surrounded by the operating coil and encased in a metal housing mounted on an octal base.



Type HG Relay



Type HGP Relay

CLARE Type HG and HGP Relays are built to meet the exacting requirements for—

Computing machines	Servo-mechanisms
Sorting machines	Relay amplifiers
Tabulating machines	High-speed keying relays
Totalizers	Signaling devices

All kinds of high-speed switching devices

Outstanding features of CLARE Type HG and HGP Relays

ELECTRICAL FEATURES

LONG LIFE: Conservative life expectancy of over a billion operations when operated within ratings.

HIGH SPEED: Give consistent performance at speeds up to 60 operations per second.

HIGH CURRENT—and voltage-handling capacity (up to 5 amperes, and up to 500 volts).

UNIFORMITY: Operating time varies by only about 0.1 millisecond under constant drive conditions.

CHATTER-FREE: Mercury dampens armature vibration and bridges mechanical chatter between metal contact surfaces.

MECHANICAL FEATURES

- Small chassis space required
- Convenient plug-in mounting
- Environment-free
- Tamperproof
- High sensitivity
- Maintenance-free
- No contact wear
- Adjustment cannot change

This first announcement of the new CLARE Mercury-Wetted Contact Relays is of especial importance to designers of high-speed switching machines and devices which demand accuracy and dependability of a high order.

In these relays, with their unique electrical and mechanical stability, you will find exactly the qualities this kind of apparatus requires—

—Long life (over a billion operations)
—High speed (up to 60 operations a second)
—High current- and voltage-handling capacity (up to 5 amperes, and up to 500 volts)
—Bounce- and chatter-free contacts
—Extraordinary uniformity of operation

These distinctive characteristics are achieved by the use of platinum contact surfaces, continuously wetted with mercury by capillary action, and the hermetic sealing of a magnetic switch in a protected glass capsule, filled with pressurized hydrogen.

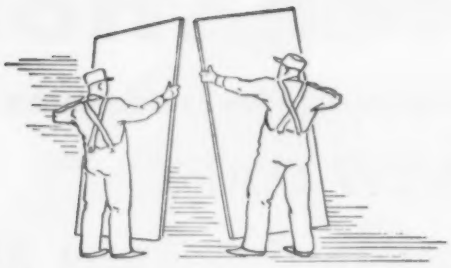
CLARE Type HG Relays comprise a switch element and an operating coil. CLARE Type HGP Relays are similar but can be factory-adjusted to provide either biased or polarized operating characteristics.

For complete information on the new CLARE Type HG and HGP Mercury-Wetted Contact Relays, contact your nearest CLARE representative or address C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois.

Send for CLARE Sales Engineering Bulletin No.120

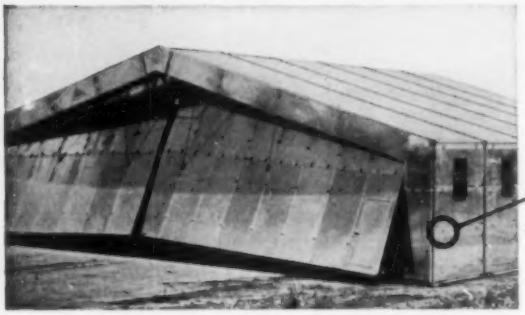
CLARE RELAYS

FIRST IN THE INDUSTRIAL FIELD



Have you a similar fastening problem?

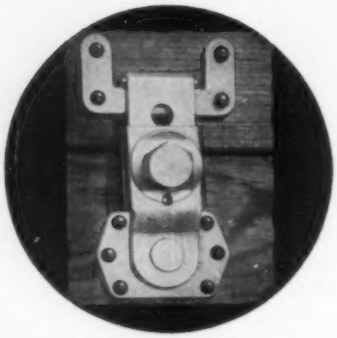
How a strong structure can be designed for speedy and simple assembly with unskilled labor, no special tools...



The U. S. Air Force wanted a jet-aircraft hangar design that would be portable by air, yet strong; would assemble quickly; be interchangeable, and flexible enough for easy structure modification.

The answer lay in a panel structure using modular units. Armorply honeycomb panels faced with thin aluminum, developed by United States Plywood Corporation, provide lightness, strength, flexibility. Joining one panel to the other in the field with untrained help was a problem until Simmons Fastener developed LINK-LOCK, a simple latching device that operates with minimum wrench pressure on hex nut.

This fastening problem is being successfully met by combining the design ingenuity of No. 1 LINK-LOCK with the proved performance of honeycomb plywood panels.



No. 1 LINK-LOCK—like No. 2 LINK-LOCK—features simplicity, positive action, high strength.

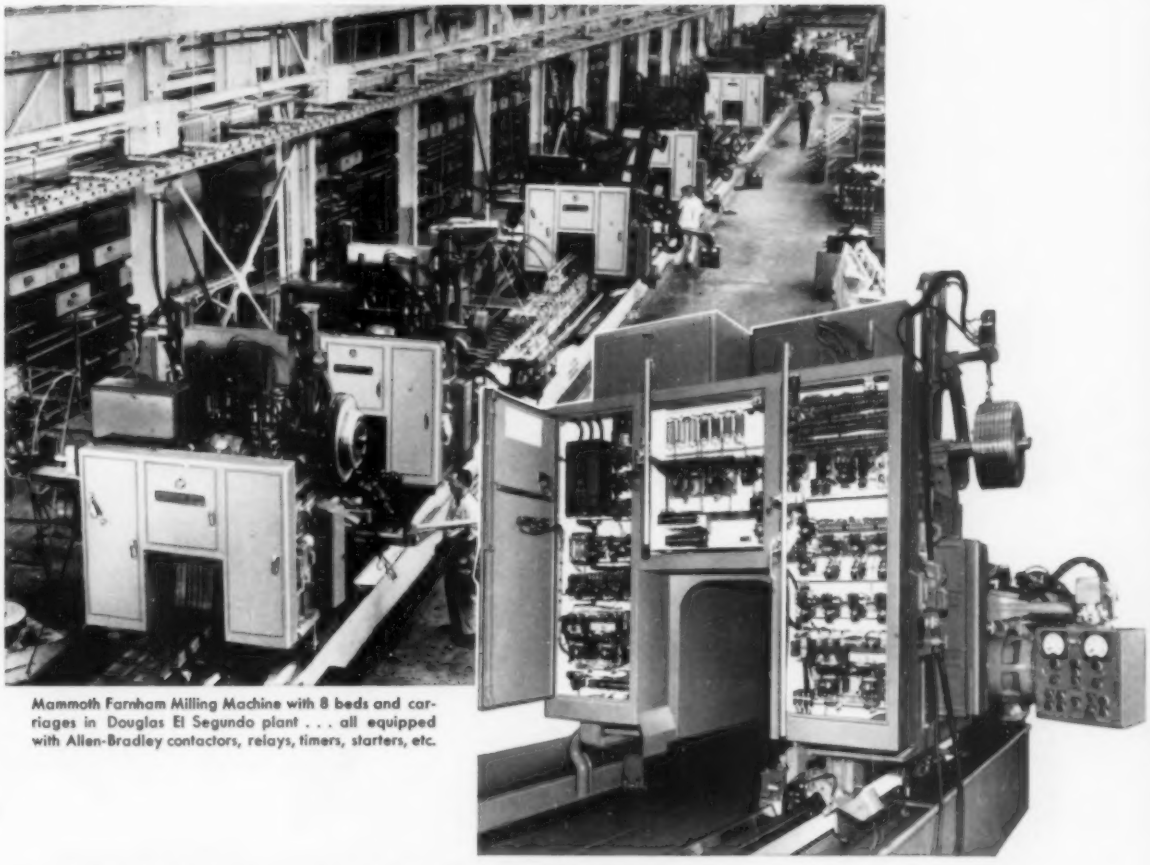
No springs are used in No. 1 LINK-LOCK. Locking action is obtained by rotating a nut that moves a sliding latch in and out of position. Up to 1500-lb. pull-down pressure is available; the device carries up to 4000-lb. tension. No. 1 LINK-LOCKS provide for surface mounting, simplifying installation.

Where can you use it? When you need heavy fastening pressures, resistance to impact, operation in 70-below temperatures—and where ease of action, compactness, and low cost are important factors. Write for a No. 1 LINK-LOCK Data Sheet.

SIMMONS FASTENER CORPORATION
1751 North Broadway, Albany 1, New York

Simmons QUICK-LOCK SPRING-LOCK ROTO-LOCK LINK-LOCK DUAL-LOCK

JUST OUT! NEW 36-PAGE CATALOG WITH APPLICATIONS. SEND FOR IT!



Mammoth Farnham Milling Machine with 8 beds and carriages in Douglas El Segundo plant . . . all equipped with Allen-Bradley contactors, relays, timers, starters, etc.

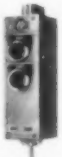
308 FOOT MILLING MACHINE
. . . operated by Allen-Bradley Motor Controls

Solenoid starter Size 1

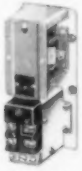
Solenoid starter Size 3

Auxiliary contacts on starter hood

Oiltight potentiometer control



Pendent push button control



Pneumatic automatic timer

Universal 4-pole relay

Oiltight push button, NO & NC contacts

Interlocking terminal blocks

Oiltight limit switch—all types

When the Farnham Manufacturing Division of The Wiesner-Rapp Co., of Buffalo, N.Y. built this impressive, 308 foot milling machine, they used Allen-Bradley control components for all 8 carriages. Thus, they assured themselves and Douglas of utmost reliability for this complex machine tool.

If you manufacture motor-driven machines, don't overlook the fact that Allen-Bradley motor controls are a big sales asset to any machine. The A-B trademark is a guarantee of trouble free performance . . . and is so recognized by machine tool buyers. Did you notice how much in evidence this trademark was at the Chicago Machine Tool Show?

Send for the Allen-Bradley Handy Catalog. It is a valuable handbook on modern motor control. Write today.

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

A-B Quality

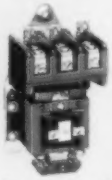
ALLEN-BRADLEY
QUALITY

SPECIAL PANELS

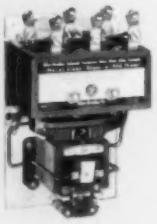
1-56-R

ALLEN-BRADLEY
A-C CONTACTORS

2 pole—Size 00
10 ampere

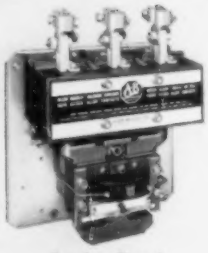


3 pole—Size 1
25 ampere

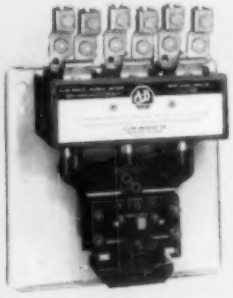


3 pole—Size 2
50 ampere

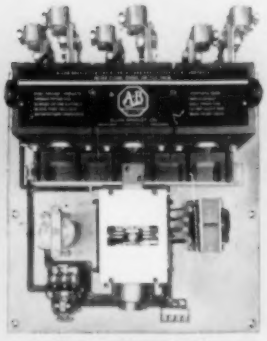
3 pole—Size 3
100 ampere



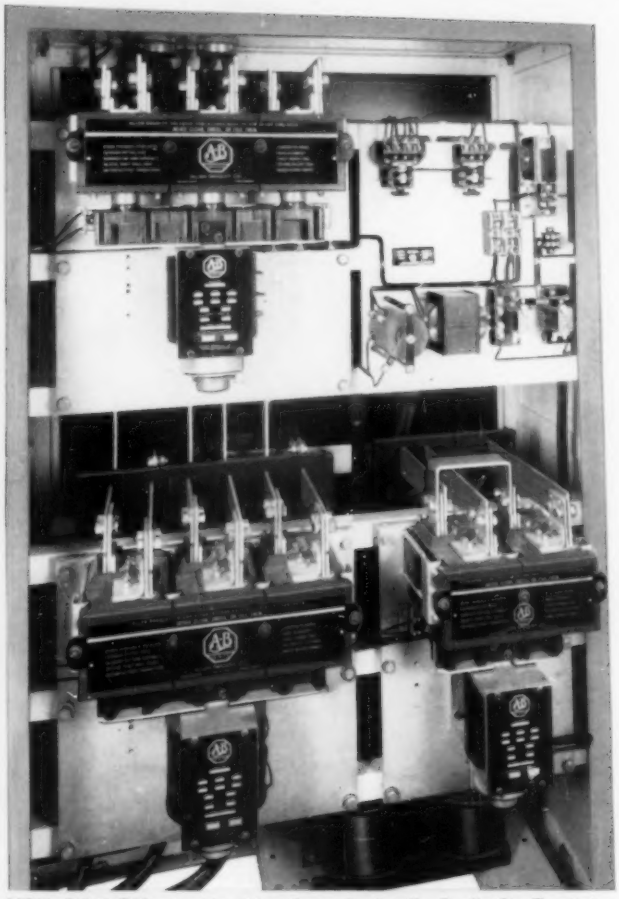
3 pole—Size 4
150 ampere



3 pole—Size 5
300 ampere



3 pole—Sizes 6 & 7
600 & 900 ampere contactors



250 Hp, Bulletin 746 automatic autotransformer showing Allen-Bradley Size 7 contactors

A-C and D-C CONTACTORS
10 to 900 Amperes
with Double Break, Silver Alloy Contacts

The only complete line of solenoid contactors on the market. Allen-Bradley offers nine sizes...from Size 00 (10 amperes) to Size 7 (900 amperes), one to four poles.

There is no contact maintenance . . . no pins, pivots, or bearings to give trouble. Just one moving part—the simple solenoid plunger. Operating characteristics are consistent for all nine sizes.

Enclosures can be supplied for general purpose, water-tight, dust-tight, and explosion-proof service.

Allen-Bradley controls are an added sales asset to any machine. May we send you our catalog?

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

A-B Quality

ALLEN-BRADLEY
SOLENOID CONTACTORS
QUALITY

1-56-MP

Put Two More Draftsmen In Space Now Occupied by Four!

Yet Give Each Man More Efficient, Comfortable Working Room . . .

with Hamilton Auto-Shift Tables — from Bruning!

Save Space — Get 30% More Use from Present Area. The same floor space (about 250 square feet) taken up by *four* boards with separate reference desks will easily accommodate six Auto-Shifts. Auto-Shift combines a board and reference desk in one compact unit. The draftsman uses the board of one table while utilizing the large reference surface and drawers of the table behind him. This dual utility saves you space for other advantageous use or lets you put more draftsmen to work in your present space.

Eliminate Waste Motion — Save Man Hours. Auto-Shift eliminates needless detours for reference material and supplies. The draftsman merely turns on his stool and pulls forward the reference surface of the Auto-Shift Table behind him, or reaches into one of its conveniently located drawers for whatever materials and tools he needs.

Reduce Draftsman Fatigue — Boost Productivity. Auto-Shift provides fast, easy board adjustment—lets the draftsman change working position often for greater comfort and efficiency. Convenient foot release frees top for height adjustment. Hand release permits quick, easy slope adjustment—slight fingertip pressure sets counterbalanced top at any desired angle. Draftsman can reach any part of the board without strain whether seated or standing.

Mail coupon below for detailed information on the important savings offered you by Auto-Shift.

Only Auto-Shift Offers You These 3 Big Advantages!

1. Only Auto-Shift offers instantaneous, positive adjustment of slope.
2. Only Auto-Shift provides instantaneous height adjustment, lets draftsman switch standing or sitting positions, quickly and easily.
3. Only Auto-Shift lets draftsman work on any part of the board without leaving his seat.

Ask your Bruning representative for information about the Bruning-Hamilton free analysis and planning service for improving your drafting operation — or use coupon at right. No obligation.

BRUNING

America's Leading Supplier of Engineering and Drafting Equipment

Charles Bruning Company, Inc., 4700 Montrose Ave., Chicago 41, Illinois
In Canada: Charles Bruning Company (Canada) Ltd., 105 Church St., Toronto 1, Ont.

Charles Bruning Company, Inc.
4700 Montrose Avenue Chicago 41, Illinois Dept. 14-O

☐ Please send me information on Hamilton Auto-Shift Tables.
☐ Send me information on the Bruning-Hamilton free analysis and planning service.

Name _____ **Title** _____

Company _____

Address _____

City _____ **County** _____ **State** _____

HOW A NATIONAL-STANDARD WIRE DEVELOPMENT *keeps her hair prettier all day long*

Millions of pounds of steel are used each year to make bobby pins.

And it's a tricky steel to make, as we learned while developing it . . . tricky, that is, if our customers were to avoid fabricating troubles and hold manufacturing costs to a minimum.

We had to produce a special kind of round wire that could be flattened without cracking. It had to have an extremely uniform finish to facilitate coloring and to permit high speed processing without frequent costly adjustments of machinery. It had to be suitable for tempering to give the right springiness and tension.

Not only did our engineers succeed in meeting all of these challenges, but they also were able to save our customers money on manufacturing, packaging and handling.

We solve problems like these every day for our customers and give them better, more complete service than they get elsewhere. That's why National-Standard is industry's foremost supplier of special wire, wire cloth and strip steel. May we serve *you*, too?

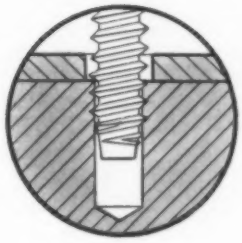
NS NATIONAL-STANDARD Company NILES, MICHIGAN

NATIONAL-STANDARD COMPANY • NILES, MICHIGAN
Tire Wire, Stainless, Fabricated Braids and Tape
ATHENIA STEEL DIVISION • CLIFTON, N. J.
Flat, High Carbon, Cold Rolled Spring Steel
REYNOLDS WIRE DIVISION • DIXON, ILLINOIS
Industrial Wire Cloth
WAGNER LITHO MACHINERY DIVISION • JERSEY CITY, N. J.
Special Machinery for Metal Decorating
WORCESTER WIRE WORKS DIVISION • WORCESTER, MASS.
Round and Shaped Steel Wire, Small Sizes

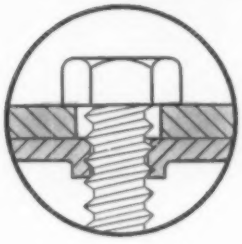
For Self-tapping Screws that...

Start Right

Drive Right



Seat Right



Millions in savings made with P-K Screws since they were originated by Parker-Kalon have proved the Self-tapping Screw *method* reduces assembly costs.

But it takes more than the right method to make sure planned savings pay off. It takes P-K quality standards to guard against defective screws that cause assembly trouble, costly damage to parts, and hidden weakness that shows up in customer complaints.

Only Parker-Kalon can offer P-K quality, the indispensable extra, along with the proved advantages of Self-tapping Screws.

Plan your assemblies for lowest cost . . . a P-K Assembly Engineer will help you. Then make sure *planned* savings *keep on paying off* . . . when you purchase, order "P-K". Parker-Kalon Division, General American Transportation Corporation, Clifton, New Jersey

Stay Tight

PARKER-KALON®

The First **SELF-TAPPING SCREWS**

originated by P-K . . . and *first* today . . .
the leading choice for fastening economy

Remember **P-K** means **OK**

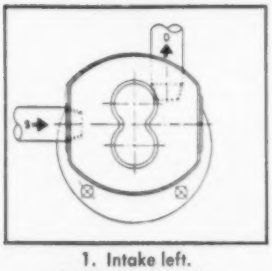
New MONOBLOC lets you hook up

WORTHINGTON MONOBLOC PUMP

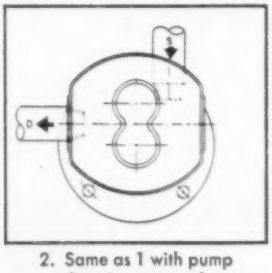
type GAFT, features rotary pump and close-coupled motor. It's just like the famous Worthington Monobloc centrifugal pump line except that coupling allows easy pump removal.

How you can use dual intake and discharge openings

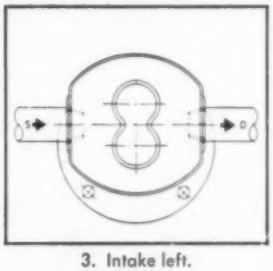
HERE ARE EIGHT OF THE 28 POSSIBLE ARRANGEMENTS:



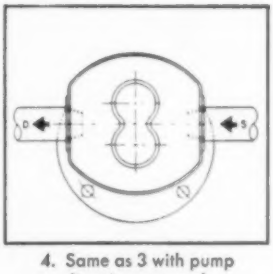
1. Intake left. Discharge top right.



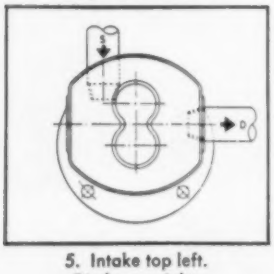
2. Same as 1 with pump direction reversed.



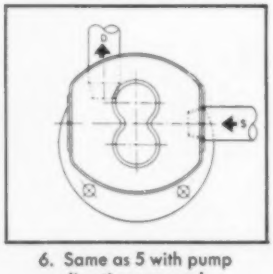
3. Intake left. Discharge right.



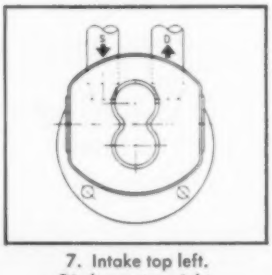
4. Same as 3 with pump direction reversed.



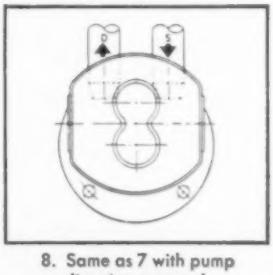
5. Intake top left. Discharge right.



6. Same as 5 with pump direction reversed.



7. Intake top left. Discharge top right.



8. Same as 7 with pump direction reversed.

rotary pump piping 28 ways!

This new Worthington Monobloc rotary pump is easy to design into compact new equipment or to adapt to existing layouts.

Dual suction and discharge openings, reversible pump direction, and four pump flange positions on motor add up to 28 possible arrangements to simplify pipe layout.

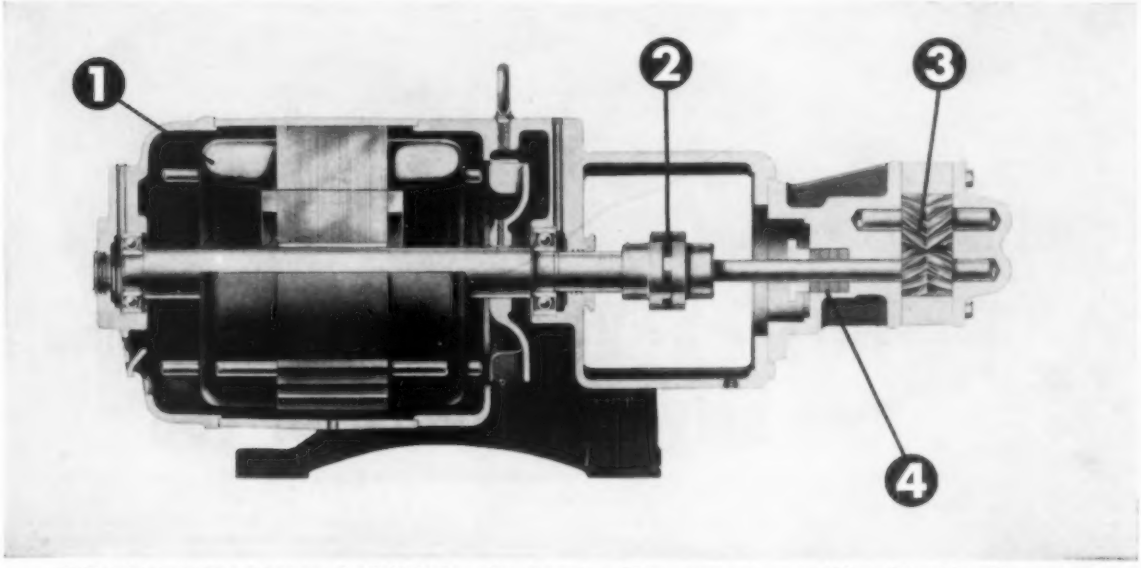
The Monobloc motor, on the new rotary, effects the same savings it has marked up for years on Worthington Monobloc centrifugal pumps. Fewer parts mean a more compact overall assembly that's easier to manufacture so it costs you less than separate pump, motor, coupling, and baseplate.

Standardization of pump and motor flange diameters and shaft lengths permit any pump to be mounted on any Monobloc motor.

There are no alignment problems with the Monobloc. Pump and motor are automatically aligned — eliminating end-thrust, binding, pipe strains, and resulting pump wear.

It's easy to service, too. A shaft coupling on the Monobloc rotary allows pump removal without disturbing the motor.

Get the whole story on the new Monobloc rotary pumps, type GAFT. Write today for bulletin W-484-S1. It gives complete data on features and applications. Worthington Corporation, Section PC.5.21, Harrison, New Jersey. PC 5 21



CUTAWAY VIEW OF GAFT PUMP. Available in four sizes, from 2 to 27 gpm at heads up to *150 psi.* Note Monobloc motor (1) available at 1800, 1200, 900 rpm, for all commonly used voltages, phases, and frequencies; motor-pump coupling (2) that allows quick pump removal; all-iron herringbone gear pump (3); packed stuffing box (4); a mechanical seal and/or relief valve are optional standard features.

WORTHINGTON

SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON *YOUR* EQUIPMENT

Compressors • Pumps • Multi-V-Drives • Allspeed Drives

STAINLESS and TOOL STEELS
HIGH-TEMPERATURE ALLOYS
and OTHER STEELS

A-L HOT EXTRUSIONS (solid and hollow) may solve problems for you

Help! (Dept. PE-73)

We have a parts problem that hot extrusions might solve. Let's see an AL representative for facts and figures.

- ☐ STAINLESS STEEL
- ☐ TOOL STEEL
- ☐ HIGH TEMPERATURE STEEL
- ☐ OTHER STEELS

Name_____

Company_____

Address_____

Where can these leading advantages of hot-extruded special alloy steels apply to your production?

1. Hot extrusions require very little finishing before use, even in the case of involved shapes. The scrap loss is small and you can buy raw materials closer to finish size. You buy less high-cost steel, cut away less of it . . . save both in time and material cost.

2. The range of shapes, solid or hollow, which can be hot-extruded is almost infinite. They can be easily and quickly produced in any quantity. Dies for new or experimental parts cost little and can be made up fast.

● We're ready to serve your needs with hot extrusions in any grade of stainless or high temperature steel, many tool steel grades and other steels. Call us in to help. ***Allegheny Ludlum Steel Corporation, Oliver Building., Pittsburgh 22, Pennsylvania.***

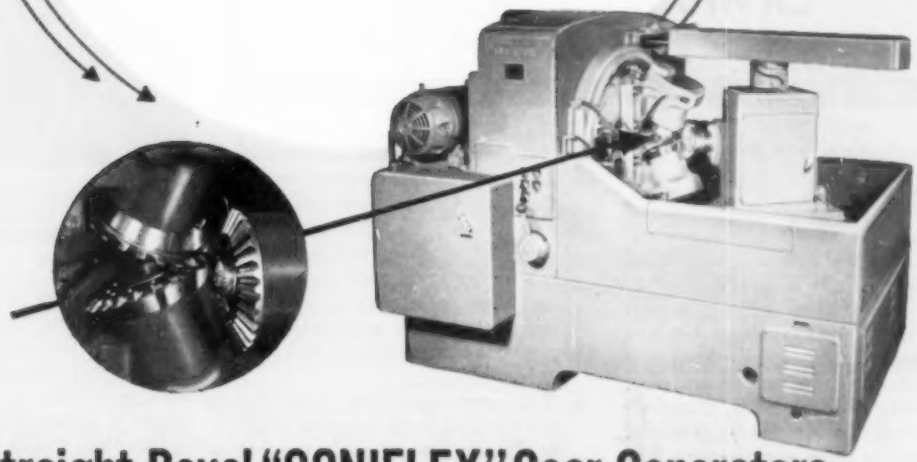
Leading Producer–High Alloy Steels

Allegheny Ludlum

AL® TIME-TESTED STAINLESS STEEL

WAD 5310

Something New at ILLINOIS GEAR



In Straight Bevel "CONIFLEX" Gear Generators

It's a great new improvement in bevel gear generators. It's here now, at Illinois Gear, ready to work on your gear orders.

It's another step forward at Illinois Gear—more fine, new machine tools added to our ever expanding production facilities to give you faster service and finer quality. Installing the finest in new and improved equipment is a constant activity at Illinois Gear. It is in keeping with our policy of being "first with the finest." Send your next gear order to Illinois Gear—get the utmost in service and quality.

Look for this mark ILLS® . . . the symbol on finer gears

ILLINOIS GEARS Reg U.S. Pat Off

Gears for Every Purpose ... one gear or 10,000 or more

ILLINOIS GEAR & MACHINE COMPANY

2108 NORTH NATCHEZ AVENUE • CHICAGO 35, ILLINOIS

7 CUES
ON HOW YOU CAN CUT FABRICATING COSTS WITH ALCOA® ALUMINUM EXTRUDED SHAPES

WHERE TO START

Just in case you've never had occasion to inquire into the economics of extruded shapes, here's a thumbnail summary in one sentence: complicated cross sections are easy to produce; as a result, their unit prices are low.

So you can count on better design, and faster assembly (and, of course, lower costs) by using extruded shapes for complex cross-section parts. For example:

1. You can get stronger shapes with the same amount of metal, if you use an extruded shape instead of a standard rolled shape. (You can redesign the cross section to fit specialized stresses your use requires.)
2. You can combine into one shape what would otherwise be assemblies of several members. There's hardly any limit to the number of cross sections you can combine.
3. You can cut blanks from an extruded shape faster and cheaper than you can produce the blanks in casting or forging form. (It's like cutting bite-size pieces of candy from a roll, instead of molding each piece separately.)
4. You can start with the finished design of the cross section, rather than standard bar and plate that must be machined to shape. (This cuts out much of the expensive machining equipment, man power and scrap metal you'd inevitably run into with conventional methods that start from scratch.)
5. You can count on structural strength at least as good as, if not better than, that of any other metal-forming method. (Extrusion kneads the metal thoroughly, giving a nonporous, homogeneous, thoroughly worked structure that is extremely high in tensile and yield strength.)

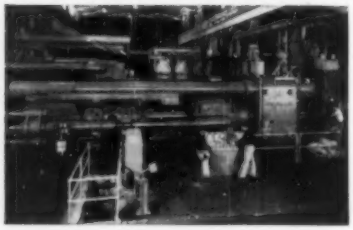
And, remember—"We can do what you can doodle. If you can sketch the cross section, we can extrude it."

That's where to start. Now for some specifics you should know about when you're thinking in terms of Alcoa Aluminum Extruded Shapes.

WHAT'S NEW IN ALCOA EXTRUSION DESIGN?

In terms of cross section, almost every extruded shape we produce is new—because there's an almost limitless variety of design, both solid and hollow. But that's not the kind of design development we're talking about.

The big news is the installation of a 14,000-ton giant extrusion press at our Lafayette, Indiana, plant—and a companion hydraulic stretcher with a 3,000,000-lb pull, for straightening and stress-relieving the extrusions—which can be as long as 110 feet and weigh as much as 2,500 lbs.



King-size contribution to better aluminum extrusions—the 14,000-ton press at Alcoa's Lafayette, Indiana, plant.

You may never need an extruded shape that big—but large presses still are important to you as a designer. Even though the shape you want is shorter or lighter, you can design a larger and thinner cross section than would be possible with a small press.

The boys who are finding this king-size production facility a particular boon are the aircraft designers. They're able to get ribbed extruded shapes in greater widths and with thinner cross sections for use in wing panels and bulkheads. But they aren't the only ones benefited. The new press capacities are equally applicable on extruded panels for architectural and marine use, (and on the production of pipe in diameter sizes up to 20″).

And the best news is that smaller shapes such as those used in the manufacture of window frames, truck bodies and frames, building panel and portable irrigation pipe are becoming more and more economical to produce on Alcoa's complete range of extrusion presses.

WHAT ABOUT COSTS?

You've a pleasant surprise in store for you if you are a new convert to the efficiency of extruded shapes. Not only can you do things that would be impossible by any other metal-forming method, and things that otherwise would cost more in fabrication, assembly and finishing—but base costs are low, too.

The die and support tools to produce an extruded shape are normally much less expensive than the first costs for a forging, casting or fully machined part. For example, the average solid extruded shape under 3″ in circumscribing circle diameter would have die and tool charges of only about $120—and one with a 5″ circumscribing circle diameter would increase the charges to approximately $300. More complex and larger shapes, of course, require higher cost dies—as do semi-hollow and hollow shapes. But they're still economically low.

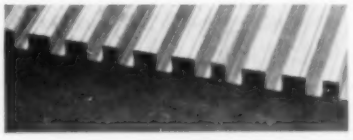
There are two considerations you should know about when you design special shapes. First, the thinner the shape, the more difficult (and, hence, more expensive) it is to extrude. Second, the same is true the more you depart from a symmetrical, balanced cross section.

These are combined in a "factor"—the result of dividing the perimeter of the shape in inches by its weight per foot in pounds. Generally, the lower the "factor," the lower the price per pound. But bear in mind that the higher cost per pound of thinner shapes may be more than offset by the lighter weight per piece, thereby justifying the expenditure.

In any event, where substantial production is involved, die charges are almost negligible compared to the savings. And where a special design would not justify the die charges, there are many standard shapes on which no die charge is made. These include a range of angles, bars, channels, H-beams, I-beams, tees, zees and a number of architectural, truck body and aircraft shapes.

HOW TO MULTIPLY CROSS-SECTION SIZE

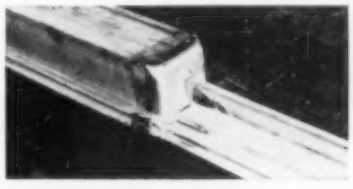
Suppose, for example, you wanted an extruded shape with a cross section measuring 20″ x 3″. You may be able to divide the final section into six or eight 3″ deep components, producing each section as a separate extrusion that will interlock with its mates to form the final cross section, 20″ x 3″. Slip-fit or snap-fit joints speed assembly, using dovetail, tongue and groove, shiplap or offset couplings designed into the separate sections. And you've multiplied the size of the final shape without multiplying production costs as much as you would if you had started with one 20″ extrusion. Then, too, you can get a thinner section than by extruding the entire assembly in one piece. If desirable, we can even deliver the components roll-locked into one final piece up to 24″ wide.



How to make big ones out of little ones—interlocking assemblies of extruded components.

STEPPED EXTRUDED SHAPES

The aircraft industry needs no introduction to this innovation—for stepped extrusions are being used in large volume for wing spars. Basically, these stepped shapes provide two or more cross sections in a single extruded length, permitting fabrication of a large end integral with and stepped down to a smaller cross section at the other end. In this way a tapered section can be milled, leaving a large, heavy end for attachment purposes. The saving in machining time and chips is tremendous.



Stepped extrusion—saves machining.

WIDE-RIBBED EXTRUDED SHAPES

Here's another twist, made possible by the 14,000-ton press, that's expanding the possibilities for extruded shapes. To obtain widths appreciably wider than the diameter of the extrusion ingot, wide sections are extruded in a vee configuration, then flattened and given final processing.

NO LIMIT ON INGENUITY

If you can doodle the design, we can extrude it. That's no idle boast—and here's a typical example to prove it: Epco Snap-On acoustical walls are the result of an idea brought to our extrusion engineers in the development stage. And the outcome is a decorative, highly useful way of installing acoustical board with a minimum of time and expense. An aluminum extrusion forms the mounting channel which is fastened to the old wall. A mating male channel, also an extrusion, carries the perforated acoustical board—and this can be snapped into place in a matter of minutes, or removed for painting, washing or alterations.

Epco Snap-On Walls—an outgrowth of an idea that depends on Alcoa Aluminum Extrusions (E-1 and E-2.)

STRAIGHT TALK

Many a production problem is being solved by Alcoa Aluminum Extruded Shapes. And when you want us to contribute solid technical thinking at the design stage, call your local Alcoa sales engineer. You'll find him listed under "Aluminum" in your phone book. Use him.

Your Guide to the Best in Aluminum Value

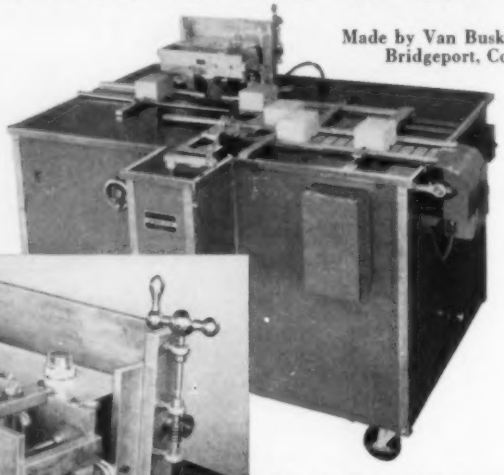
ALWAYS FASTEN ALUMINUM WITH ALCOA ALUMINUM FASTENERS

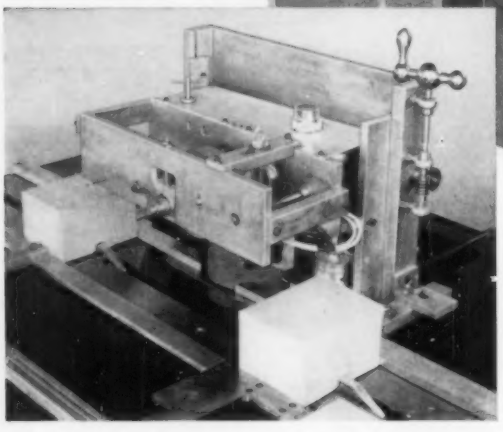
We use 23 HEIM *Unibal* ROD ENDS on each machine

"Because they cost less than specially machined parts, give us smoother action, and take less time to assemble."

The Van Buskirk marking machine imprints metal cans, folding or set-up boxes, and corrugated cartons, on 1, 2, 3, 4 or 5 sides in one pass, after they have been packed. The imprinting is in perfect register, in any color of ink or style of type, at speeds in excess of 100 per minute. This portable machine can be moved to its proper place at the end of an assembly line for automatic feeding. It eliminates the necessity of carrying a large inventory of specially printed boxes or labels.

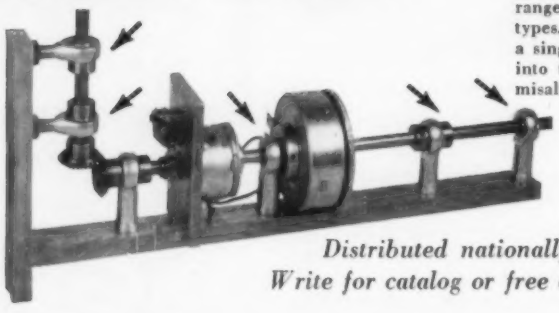
Made by Van Buskirk & Co., Inc.
Bridgeport, Connecticut





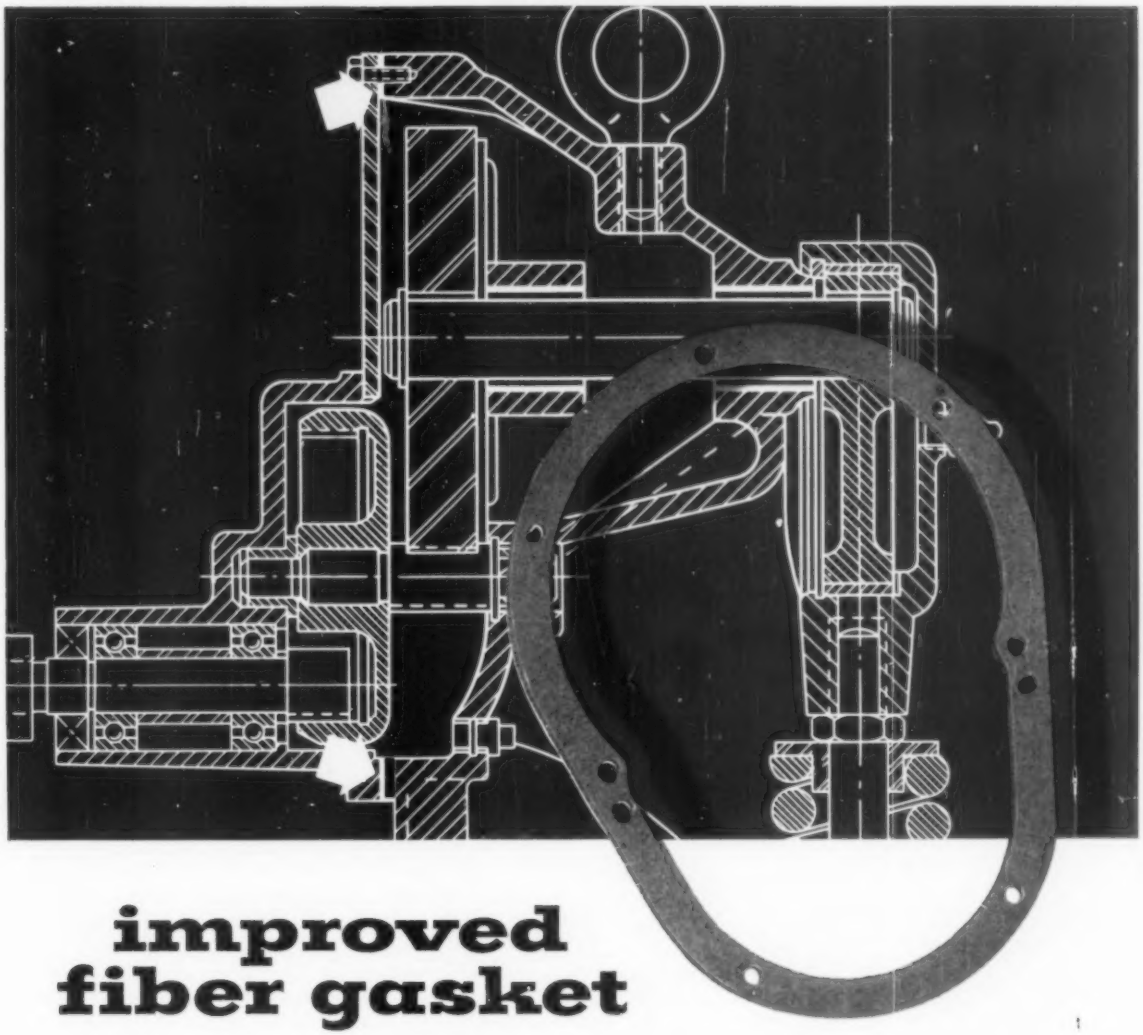
Heim Unibal Rod Ends are used on this machine not only as rod ends in the linkages, but as self-aligning supports for the split shafts in the clutch assembly and the worm gear shaft for raising and lowering the printing drums.

The Heim Unibal is made in a wide range of sizes in both male and female types. They can be installed by drilling a single hole and fastening with a bolt into the female rod end. They correct misalignment in every direction.



Distributed nationally by bearing specialists.
Write for catalog or free engineering information.

THE HEIM COMPANY FAIRFIELD CONNECTICUT



improved fiber gasket

withstands concentrated load, stops gear-case leakage

After a short time in the field, the self-priming diaphragm pumps made by a mid-western manufacturer started losing oil. The trouble was traced to the gear-case housing gaskets, which were being squeezed out of joints because narrow flanges concentrated the bolt pressure.

The oil leaks stopped, however, when Armstrong CN-705 Accopac® was used in place of the original gasket material. Because Accopac is unusually compressible and crush resistant, it maintained a perfect seal on the narrow flange. This compressibility also means that Accopac conforms to the normal irregularities in stamped flanges—as well as to those found in rough-milled flange surfaces.

Accopac won't shrink or dry out, either. It's made by a patented beater-saturation process which blends fiber and cork with a non-volatile, non-extractable latex binder. The resultant sheets are uniform, dimensionally stable, and impervious at bolting pressures as low as 800 psi.

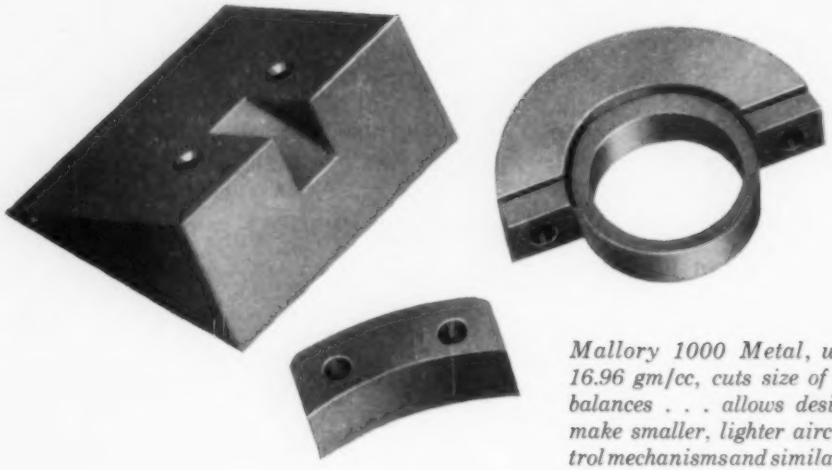
For information on how Accopac can help in specific gasketing applications, call your Armstrong man.

FREE 24-PAGE GASKET MANUAL— Look for "Armstrong Gasket Materials" in Sweet's product design file . . . or write for your own copy to Armstrong Cork Company, Industrial Division, 7001 Irvin St., Lancaster, Pennsylvania. **And be sure to specify Armstrong Gasket Materials when you order from your gasket cutter.**

Armstrong Accopac

. . . used wherever performance counts

MALLORY



Mallory 1000 Metal, weighing 16.96 gm/cc, cuts size of counterbalances . . . allows designers to make smaller, lighter aircraft control mechanisms and similar devices.

How to save weight... by using heavier metal

MALLORY 1000 METAL Proves Ideal For—

Compact gyroscope rotors

Mallory 1000, with properties especially developed for this service, gives exceptionally high inertia in small space . . . increases sensitivity of gyros.

Smaller radioactive shields

Up to 40% more efficient than lead, Mallory 1000 proves superior for shielding cyclotron and synchrotron radiation, for hot isotope storage, and for radiation switching from source.

Write for technical bulletins.

YOU can reduce the size (and thus the weight) of many control assemblies—housings, linkages, other structural elements—by trimming the dimensions of counterbalances, balance weights, and similar "mass components". High density Mallory 1000 makes this practicable. Twice as dense as steel or brass, and far stronger than lead, Mallory 1000 provides designers with the ideal material for compacting many mechanisms.

Designers will appreciate the high uniformity of characteristics which Mallory 1000 offers. Density, tensile strength, modulus of rupture, and elongation are accurate within narrow limits. You can base accurate design calculations on specific, actual figures—instead of guessing with vague "representative" properties. Mallory 1000 leads all other high density metals in adherence to firm specifications. In addition to its high density and strength, the metal offers ready machinability to high surface finish.

Wherever you need concentrated mass or inertia—in balance weights or rotating elements—it will pay you to look into Mallory 1000. Write for complete technical data.

In Canada, made and sold by Johnson Matthey & Mallory, Ltd., 110 Industry Street, Toronto 15, Ontario.

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

Expect more . . . get more from

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

For information on titanium developments, contact Mallory-Sharon Titanium Corp., Niles, Ohio

Q. How can you increase gear life and save space too?

A. With FOOTE BROS. Duti-Rated Gears.* New Engineering Manual DR shows complete standardized line designed to meet your power transmission needs.

*T.M. Reg. U.S. Pat. Off.

Write for your free copy today!

Some of today's toughest gear problems practically solve themselves with this new engineering manual. Small wonder, for it puts at your fingertips the full range of pre-engineered Duti-Rated Gear design data, specifications and selection tables. It's concise, yet complete . . . makes it easy to locate the gear set that will give you longer life and greater capacity in less gear space. It shows, too, how Duti-Rated Gears by Foote Bros. are the experience-proved way to maximum power transmission efficiency . . . oftentimes the most economical. Get your copy of Engineering Manual DR . . . now!

FOOTE BROS.

Better Power Transmission Through Better Gears

Since 1859

Foote Bros. Gear and Machine Corporation
4545 South Western Boulevard, Dept. W,
Chicago, Illinois

Now— FOR THE FIRST TIME EVER...

Laminated Shims of STAINLESS STEEL

Only in LAMINUM® can you get the unique qualities of *stainless steel* combined with the advantages of *surface-bonded laminated shims.*

Material is tough, corrosion-resistant Type 302 Stainless Steel (min. 95,000 psi). Laminations are either 0.002" or 0.003", and they simply p-e-e-l for time-saving adjustment to give you a "thousandth" fit right at the job. No machining. No grinding. No miking. And no dirt between layers!

Stainless Steel LAMINUM® Shims are custom-cut to any shape from any of our standard thicknesses; write for stainless steel specifications.

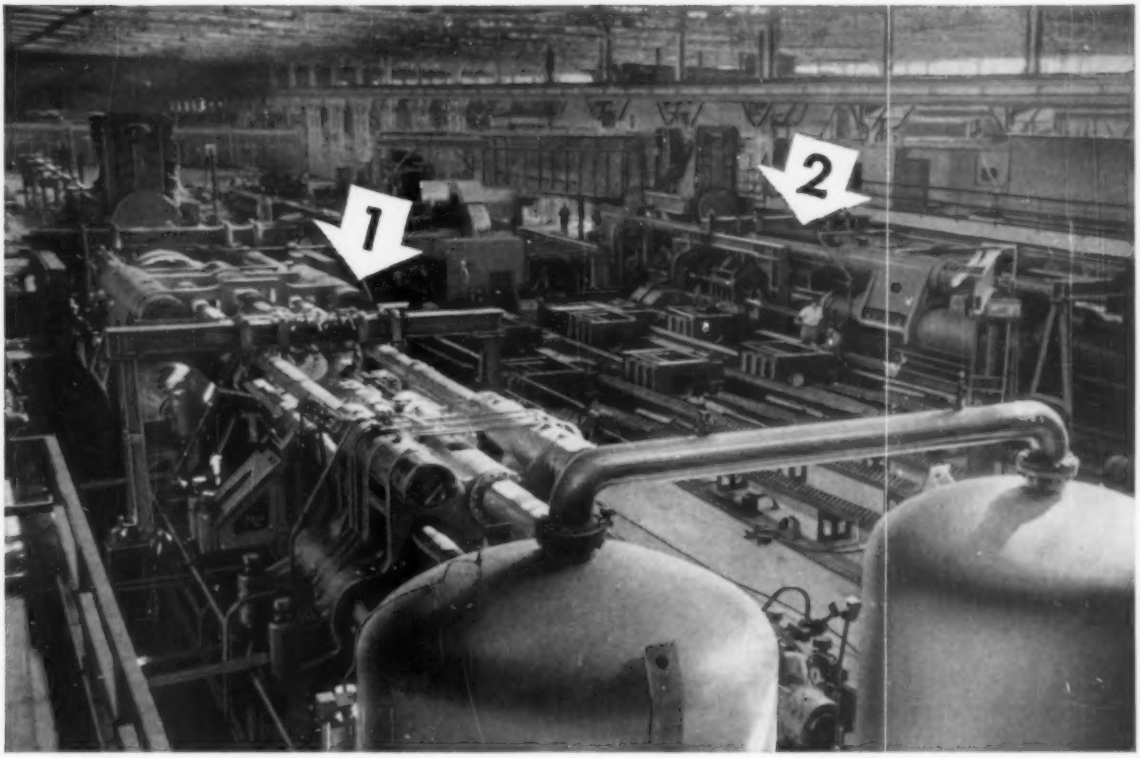
LAMINATED SHIM COMPANY, INC.

Send us your blueprints and quantity requirements for a quotation; there's no obligation.

SHIM HEADQUARTERS SINCE 1913

1401 UNION STREET, GLENBROOK, CONNECTICUT

Our two new heavy extrusion presses to benefit materials handling equipment manufacturers



In November the Kaiser Aluminum heavy press facility went into operation at our Halethorpe, Maryland plant.

Both 8,000-ton presses will provide important benefits to manufacturers of materials handling machinery. Each press can produce finished aluminum extrusions up to 17 inches wide, 85 feet long, and up to 1,200 pounds in weight. Substantially wider extrusions can be produced depending upon section design.

All types of structural shapes are possible for everything from fork lift trucks to gantry cranes. Dead weight in materials handling machinery can be eliminated or reduced—mobility and efficiency can be increased tremendously.

In many cases, the application of these large aluminum extrusions can eliminate much of the expense of manufacturing and assembling smaller parts.

The two presses are identical in size and capacity, so dies can be moved from one press to another without modification or delay. This duplication of equipment assures an uninterrupted source of large extrusions!

Kaiser Aluminum's new plant is completely equipped with the most modern facilities and fully integrated for the production of heavy extrusions exclusively.

Kaiser Aluminum engineers have had long experience in extrusion design and application. They will gladly work with you to determine how heavy aluminum extrusions can open new markets to you. Ask for a complete analysis of cost saving possibilities. You are urged to take immediate advantage of this service.

Contact Kaiser Aluminum and Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Illinois; *Executive Office*, Kaiser Bldg., Oakland 12, California.

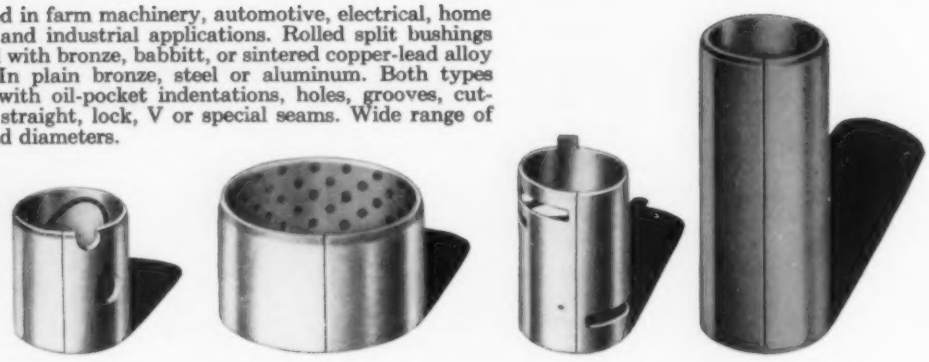
For details send for brochure, "Kaiser Aluminum Heavy Press Extrusions." Address: Room 6166 Industrial Service Division, Kaiser Aluminum & Chemical Corp., 1924 Broadway, Oakland 12, Calif.

Kaiser Aluminum

setting the pace—in growth, quality and service

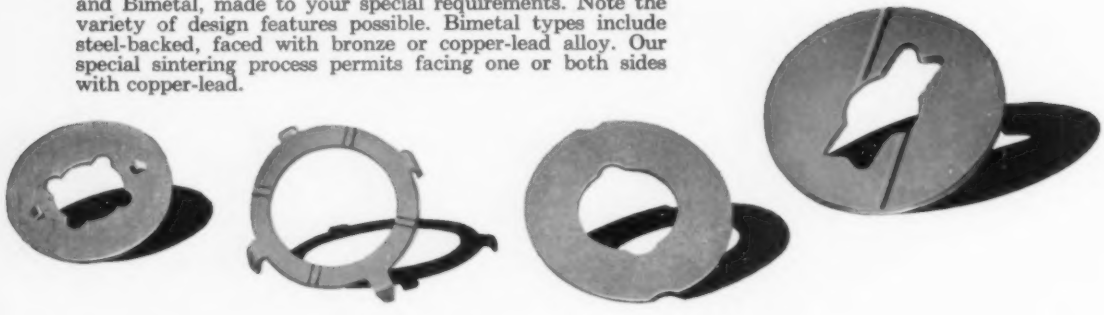
BUSHINGS

widely used in farm machinery, automotive, electrical, home appliance and industrial applications. Rolled split bushings in Bimetal with bronze, babbitt, or sintered copper-lead alloy on steel. In plain bronze, steel or aluminum. Both types available with oil-pocket indentations, holes, grooves, cut-outs, and straight, lock, V or special seams. Wide range of lengths and diameters.



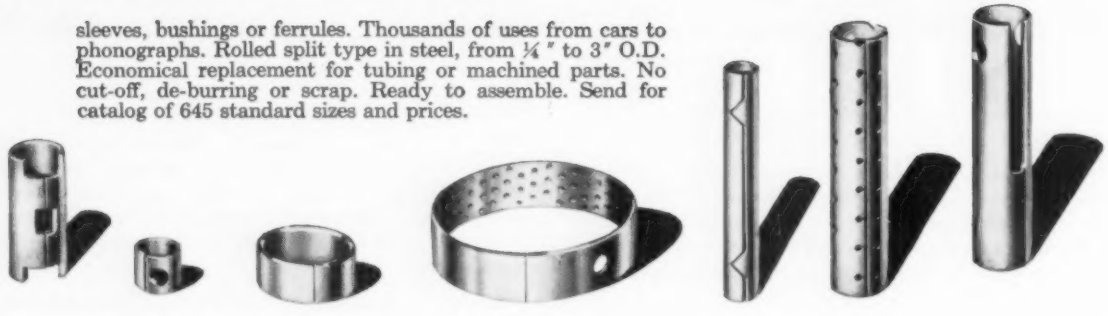
WASHERS

for automatic transmissions and similar applications. In bronze and Bimetal, made to your special requirements. Note the variety of design features possible. Bimetal types include steel-backed, faced with bronze or copper-lead alloy. Our special sintering process permits facing one or both sides with copper-lead.



SPACER TUBES

sleeves, bushings or ferrules. Thousands of uses from cars to phonographs. Rolled split type in steel, from ¼" to 3" O.D. Economical replacement for tubing or machined parts. No cut-off, de-burring or scrap. Ready to assemble. Send for catalog of 645 standard sizes and prices.



Here are exceptional facilities and equipment for low-cost quantity production of your requirements. Complete engineering service.

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

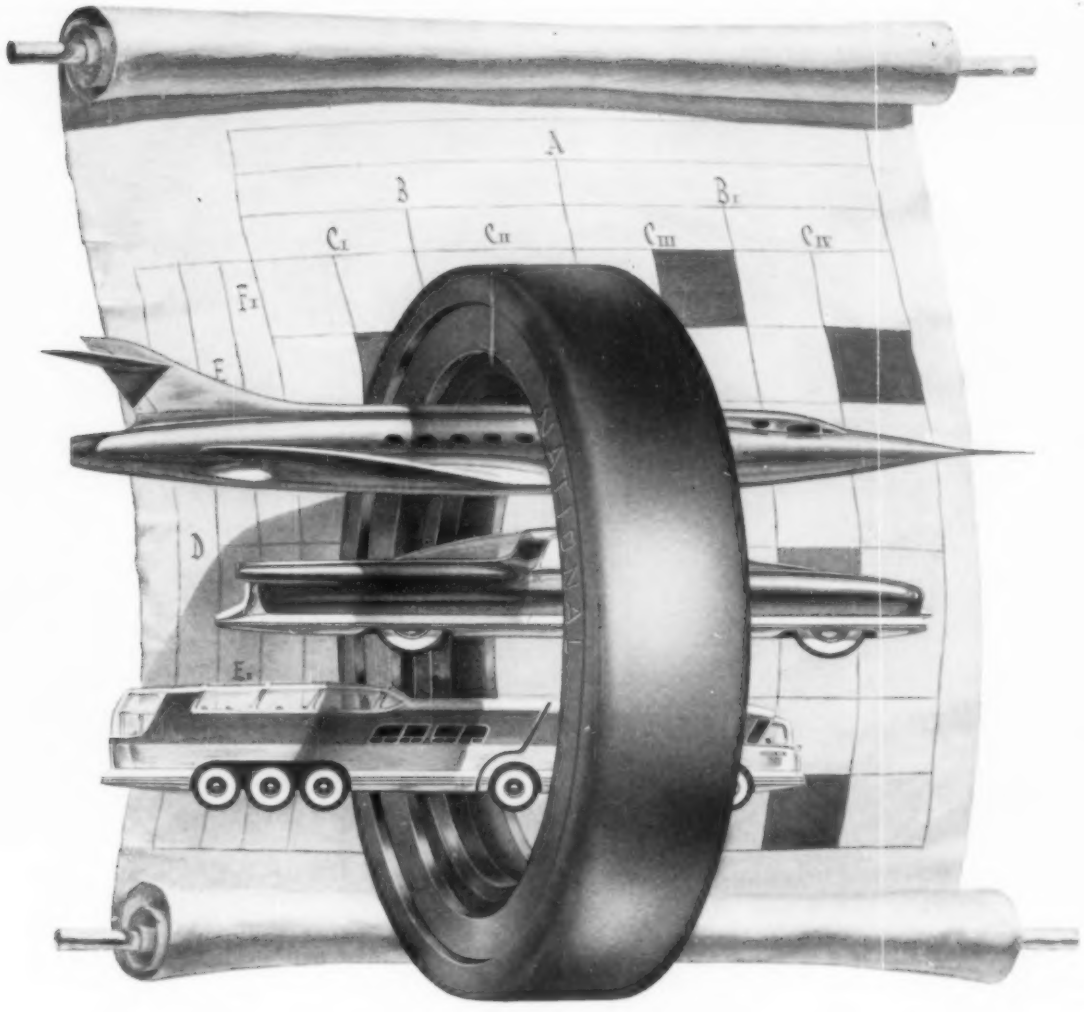
FEDERAL-MOGUL

DIVISION

FEDERAL Mogul

SINCE 1899

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11043 SHOEMAKER, DETROIT 13, MICH.



From a strange and ancient "checkerboard"... tomorrow's oil seals today!

The "Latin Square" is an age-old device mathematicians have used to speed solution of problems having many variables. Now, this same strange "checkerboard" has ultra-modern application in National's oil seal laboratories — where engineers have adapted it to predict accurately the performance of new and visionary sealing lip compounds.

In the hands of National Oil Seal researchers, the Latin Square cuts exploratory engineering time on compounding as much as 75%. Better, more dependable, lower torque oil seals can be available to you months, even years, sooner. It's another example of how pioneering, "years-ahead" engineering at National makes tomorrow's oil seals available today.

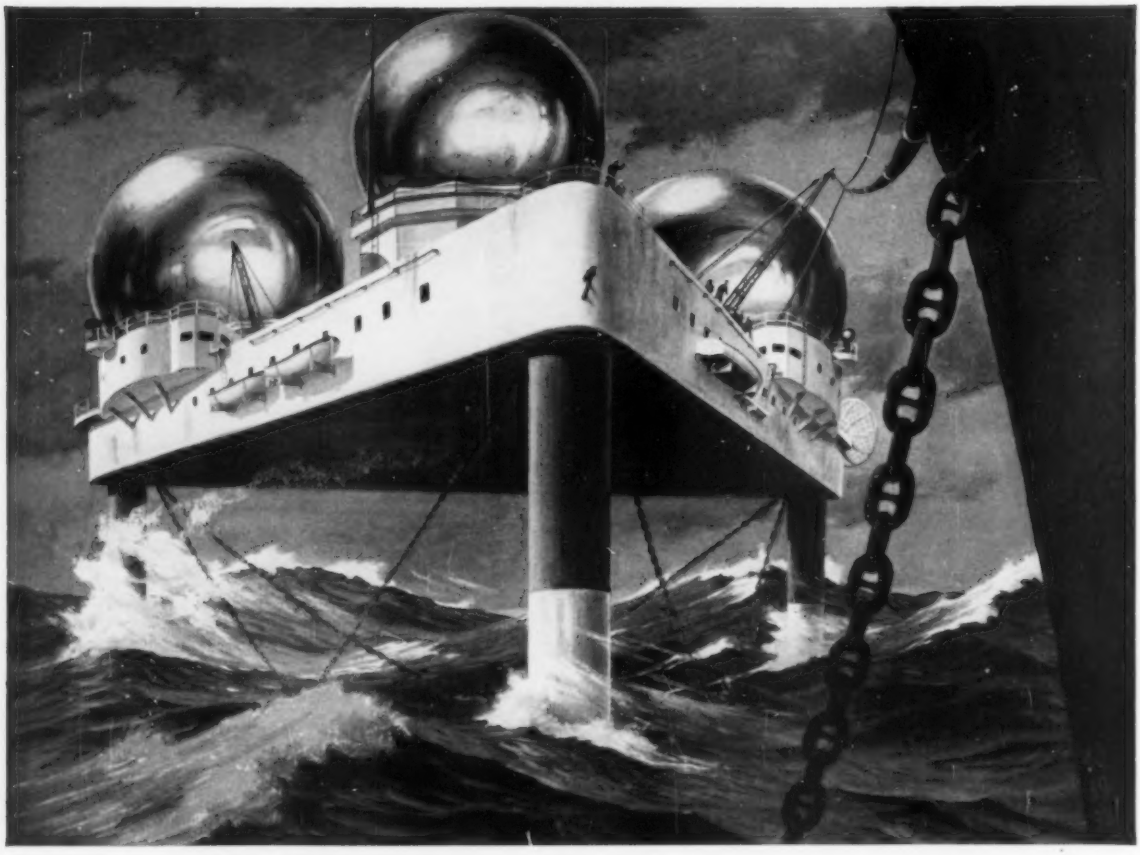
National has supplied over a billion oil seals for America's cars, trucks, buses, tractors, aircraft, railway cars, machines and household appliances.

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, California. Sales Offices: Chicago, Cleveland, Dallas, Detroit, Downey (Los Angeles County), Indianapolis, Milwaukee, Newark, Van Wert, Wichita. Plants: Redwood City, Downey and Long Beach, California; Van Wert, Ohio.

NATIONAL OIL SEALS

3417



100 miles out in the Atlantic:

Monel keeps "sea legs" sturdy under the Navy's man-made islands

A radar network at sea! That's what the United States wanted.

But how to do it was a question. Using boats offshore wasn't the answer. Nor planes. Nor balloons.

Then somebody came up with a startling idea. A string of artificial islands! Build them on the Continental Shelf from Nova Scotia to the Virginia Capes.

Again there were problems. How would you build these offshore radar platforms in deep water? The design has to take into consideration many hazards. Among them pounding waves. Tides. Hurricane winds. And corrosion!

Salt water and steel pilings make ugly neighbors. This is particularly true at the water line — in what is technically known as the "tidal and splash zone." Surfaces are sometimes wet, sometimes dry. Corrosion has a field day if you give it half a chance. The Government men benefited by the experience of oil men. Drilling out in the Gulf of Mexico, they had found the answer:

Steel with an outside layer of Monel nickel-copper alloy permanently bonded to it for protection!*

Like all Inco Nickel Alloys, Monel nickel-copper alloy never rusts. And it has high resistance to corrosion by salt water . . . salt air . . . salt spray. It does a job no other material can do. And does it well.

Do you need a metal to withstand destructive conditions? Corrosion? High temperatures? Fatigue? Then write for the booklet, *Standard Alloys for Special Problems*. It answers many questions about Monel alloy and other Inco Nickel Alloys. Puts you squarely on the track of the Inco Nickel Alloy best suited for your purpose! Write for this valuable booklet — *today*.

*Registered Trademark

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

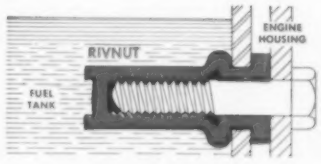
50 YEARS OF *Nickel Alloy Progress* PIONEERED BY MONEL 1905-1955

INCO TRADE MARK

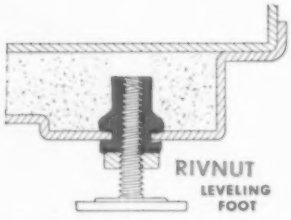
INTERNATIONAL NICKEL
67 Wall Street New York 5, N. Y.
Nickel Alloys Perform Better, Longer

B.F. Goodrich Rivnut

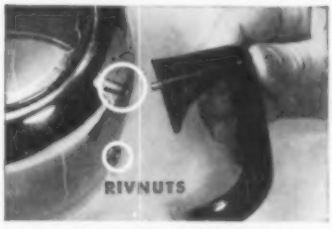
solves practically any fastening problem



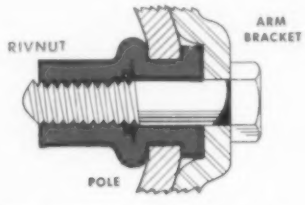
MAKES NUT PLATE, SEAL. Quickly installed in gas tank wall, Rivnut makes firm, accurate nut plate that can't be loosened by shock or vibration. At least six threads are clean for bolt attachment to engine housing. Straps, rivets, braces, nuts are eliminated. Rivnut's special closed end makes 100% gasoline-tight seal.



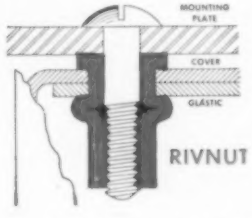
NEW WAY TO FASTEN LEVELING FEET. Appliance manufacturers install Rivnut in metal too thin to tap or weld *after* enameling. Bulge in Rivnut shank (second head) firmly grips the material. At least six threads remain clean to take the leveling foot screw—more than enough to handle the weight of heavy appliances.



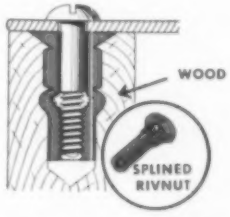
SPEEDS HANDLE ASSEMBLY. B. F. Goodrich Rivnut saves time fastening handle to small appliance. It provides a strong nut plate in *seconds*. Replaces slower fastening methods like nuts and bolts, welding, clinching, tapping. Rivnuts can be installed from one side and the open end types can take an attachment screw from either side.



CUTS ASSEMBLY COSTS 50%. In a street light application, it took two men to fasten the arm bracket to the pole. Then the manufacturer redesigned the unit to use Rivnuts. Now one man can do the job in the same time. Tests show the pole or arm bracket will fail before the Rivnuts.



DOES TWO FASTENING JOBS. Rivnuts simplify transformer assembly from start to finish. Starting with unassembled parts, worker fastens sheet of plastic to metal cover with Rivnuts. With cover secured to frame, the Rivnuts then serve as mounting plate.

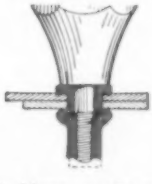


NEW WAY TO FASTEN TO WOOD. Special splined Rivnut for solid fastening in wood eliminates wood screws, provides six metal threads for attachment bolt. Bulge formed in shank holds Rivnut fast. Splined shaft keeps it from turning. Used for bus seats, metal backs in TV sets, etc.

How Rivnuts provide at least 6 clean threads in one simple operation!

1 Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.

2 Rivnut is inserted—head firmly against work—tool at right angles to work.



3 Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.

4 After upset, Rivnut threads are still clean and intact, ready for screw attachment.

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO and WITH. Explains construction, simplicity of installation. Get your free copy by writing to: The B. F. Goodrich Company, PE-16, Akron, Ohio.

B.F. Goodrich RIVNUTS

The only one-piece blind rivet with threads

How papers by Mosinee make products safer, more efficient

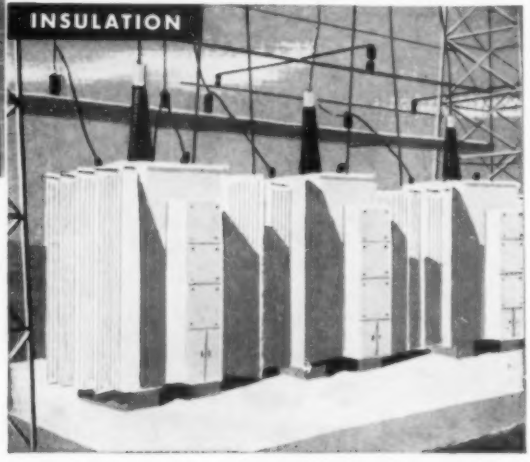
From cooling rooms to heating homes or guarding electrical apparatus – Mosinee specially developed papers help do the job better.

IN these and hundreds of other cases involving insulation, fabrication, lamination, processing or packaging — Mosinee papers play an important part in getting optimum results with minimum trouble and expense.

It will pay you to find out how Mosinee experts cooperate with industry to develop specialized papers. Current applications of Mosinee papers will suggest immediate ways in which you can make substantial savings in time and money. Write today for complete information.

Evaporative cooler pads for room coolers are made from Mosinee controlled paper. A high rate of moisture absorption with wet strength are two of the critical properties of this highly specialized paper. In addition, this paper must be adapted to easy slitting and expanding in the conversion operation for pad construction. Here's typical Mosinee precision control at work.

Mosinee flame-resistant papers increase safety factor of filters employed in warm air heating systems. The process of making these papers flame-resistant was developed by Mosinee technicians. This process, applicable to many types of paper, may help you solve a product or processing problem.



Special analysis Mosinee papers improve performance of electrical components. These electrical insulation papers must be closely controlled to provide a low ash and chloride content. They are used extensively as layer insulation between turns of field coils and in transformers — from the smallest to one of world's largest. Ask about Mosinee papers for your electrical requirements.

MOSINEE PAPER MILLS COMPANY
DEPT. PE • MOSINEE, WISCONSIN

Mosinee

Specialists in industrial paper technology — makes fibers work for industry.

Keystone

• leadership in powder metallurgy research, design and manufacture since 1927

research

widens powdered metal horizons every year

Beginning with pioneer work on the pre-oiled bearing, Keystone powdered metal research went on to develop the famous D-10 brass-graphite formula (a true oilless bearing material). Then, to iron bearings, with research and testing experience on iron bearings unsurpassed in the industry. Today, special corrosion-resistant finishes, the first successful stainless steel parts, and new high density alloy steel parts for structural applications are outstanding Keystone achievements. On the way: titanium parts, extrusion of powdered metal compacts, improved finishing techniques, for ever-better products.

design

always in the forefront of progress

Mastery of die design for parts of bronze, brass, iron, aluminum, nickel silver, stainless and alloy steels is the result of unrivalled Keystone experience and production know-how. Designing for economy and practicality of production extends also to equipment, much of which is original in design for greater versatility and lower cost for the customer. Among many Keystone design firsts: the molded flange in the middle of a bearing, and below-commercial-tolerance bearings at no increase in cost—notable achievements in the field.

manufacture

combines the facilities and capacity you need

Keystone produces more than 86,000,000 pieces—over 2,500,000 pounds—of powdered metal parts per year. This production capacity is governed by elaborate quality controls and a complete pilot plant division, where all dies, equipment and powder grades are carefully checked out before mass production begins. Regardless of the size or complication of your powdered metal part requirements, you will find complete ability to handle them satisfactorily at Keystone. We will be glad to furnish quotations on your specific applications. Let us consult with you, without obligation.

Keystone CARBON COMPANY
ST. MARYS, PENNSYLVANIA

Write for your free copy of this introductory folder on Keystone Powder Metallurgy.

Guarantee TOP Performance and Maximum Life!

Specify THESE TOP QUALITY FEATURES...

(Standard on Miller Cylinders at no extra cost)

Specify CASE HARDENED CHROME PLATED PISTON RODS

On all Air and Hydraulic Cylinders

Benefits To You

CASE-HARDENED Piston Rods (52-54 Rockwell "C") provide practically complete protection against damage from hammer blows, wrench-dropping, mishandling, and similar occurrences. ***Available from Miller at no extra cost.***

The HARD CHROME PLATING over the case-hardened rods protects against scratch-damage and rust. ***Available from Miller at no extra cost.***

Specify "TEFLON" WIPERS

On all Air and Hydraulic Cylinders

Benefits To You

"TEFLON" Rod Wipers and "TEFLON" Hydraulic Piston Rod Seals withstand temperatures from—100°F. to plus 500°F. They are impervious to practically all known chemicals, including the fire-resistant, special, and standard hydraulic fluids in current use. ***Available from Miller at no extra cost.***

Specify TEFLON HYDRAULIC ROD SEALS

On all Hydraulic Cylinders

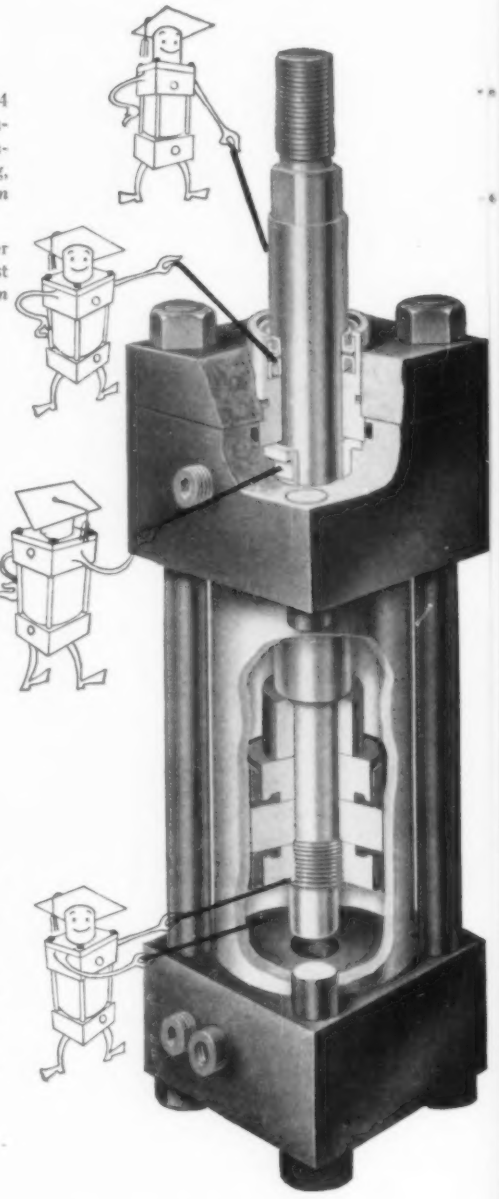
Specify RUST RESISTANT SURFACES

On all Air and Hydraulic Cylinders

Benefits To You

Highest quality Black Ferric Oxide Finish provides rust protection in air cylinder operation and on all cylinders during shipping and installation.

Cylinder heads, caps, mountings, pistons, followers, tie rods, and the unplated portions of the piston rods have this finish ***at no extra cost on all Miller cylinders.*** (This finish not recommended for water service)



You may wish to route this entire page to the proper department in your company, by using this handy form. Additional copies on request. →

To (Dept.)_____

"On all our future cylinder requirements, please specify the above quality features."

Signed_____

Title_____

EFFECTIVE DATES

These new Miller features will be provided at no extra cost after January 1, 1956—and at Miller's option prior to that date.

SALES AND SERVICE FROM COAST TO COAST

CLEVELAND • YOUNGSTOWN • DAYTON • TOLEDO • CINCINNATI • COLUMBUS
PITTSBURGH • PHILADELPHIA • BOSTON • HARTFORD • NEW YORK CITY
BUFFALO • ROCHESTER • MINNEAPOLIS • GRAND RAPIDS • DETROIT • FLINT
FORT WAYNE • SOUTH BEND • INDIANAPOLIS • MILWAUKEE • LOUISVILLE
KANSAS CITY • SEATTLE • LOS ANGELES • SAN FRANCISCO • BALTIMORE
DENVER • ST. LOUIS • MOLINE • CHICAGO • HOUSTON • ATLANTA
TORONTO, CANADA and OTHER AREAS

MILLER FLUID POWER CO.

Miller

2002-04 N. Hawthorne Ave. Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

In 1945-46 You Benefited . . .

From the following quality cylinder "Firsts" offered by Miller Fluid Power Company on its standard catalogued power cylinders:

1. Square bar steel heads, caps, and components
2. Welded fabricated steel mountings
3. Detachable, interchangeable steel mountings
4. High tensile steel tie rods (4 per cylinder)
5. High tensile steel piston rods
6. Chrome Plated Piston rods
7. Wrench flats on piston rods
8. Non-corrosive tubing on large bore air cylinders
9. Step-cut piston rings on hydraulic cylinders
10. Dirt wipers on air cylinders
11. Dirt wipers and oil wipers on hydraulic cylinders
12. Non-adjustable, bubble-tight, leakproof piston rod seals on air cylinders
13. Non-adjustable, bubble-tight, leakproof piston seals on air cylinders
14. Non-adjustable, leakproof, hydraulic piston rod seals guaranteed not to leak even one drop of oil
15. Non-adjustable, leakproof, hydraulic piston seals guaranteed not to leak even one drop of oil
16. 98% plus operating efficiency on air cylinders of 4" and larger bores at 80 psi
17. 98% plus operating efficiency on hydraulic cylinders of 4" and larger bores at 130 psi
18. 1 psi no-load break loose pressure on air cylinders of 3¼" bore and larger
19. 3 psi no-load break-loose pressure on hydraulic cylinders of 4" bore and larger
20. Seal life in excess of several hundred million feet of piston rod travel on all of the above-mentioned piston seals
21. Precision-seal cylinders
22. Seals that seal with pressure on all hydraulic static seals
23. Catalogued line of hydraulic cylinders of 2000 to 3000 psi operating pressure

In 1954 You Benefited again —from Miller's . . .

24. Sizable stock cylinder program
25. Model 77 heavy duty detachable foot mountings

In 1955 You Benefited again —from Miller's . . .

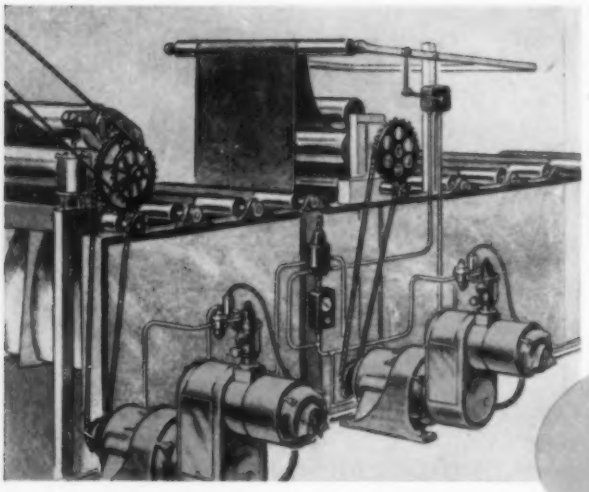
26. Greatly expanded stock cylinder program
27. Case-hardened, chrome plated piston rods
28. "Teflon" hydraulic piston rod seals
29. "Teflon" dirt wipers on air cylinders
30. "Teflon" dirt and oil wipers on hydraulic cylinders
31. High quality rust preventive finish on all parts not otherwise protected from rust on both air and hydraulic cylinders

Enter in boxes above the YEAR in which your supplier first (if at all) gave you these benefits.

In 1956, You Will Benefit Again . . .

Watch For MORE Miller Firsts!

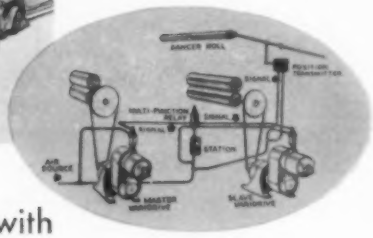
automation in action



EXAMPLE:

SYNCHRONIZATION

Speed of "master" Varidrive is set to desired speed of material. The floating or dancer roll in this process maintains a constant tension. Movement of dancer roll signals "slave" Varidrive to produce proper speed for take-up material.



Accomplishing Automatic Control with VARITROL as a component of the U. S. VARIDRIVE

By controlling motor speeds with the Varitrol as a component of the U. S. Varidrive motor, speeds can be automatically changed in response to a signal without human attention for precision-control operations. Above is shown just one of the many ways in which Varitrol automatic control of U. S. Varidrive motors can be used for automatic production control. Varitrol applications obtain efficiency and economy in industrial processes through outstanding savings in processing material, fuel and labor costs.

ADAPTABLE FOR A VARIETY OF DUTIES:

- Constant Pressure
- Proportional flow
- Constant Liquid Level
- Program Control
- Multiple Motor Control
- Filter Control
- Machine Tools
- Constant Cutting Speed
- Speed Control
- Rewind Control
- Constant Flow
- Constant Temperature

Send for Information—8-Page Full Color Booklet On Automatic Control

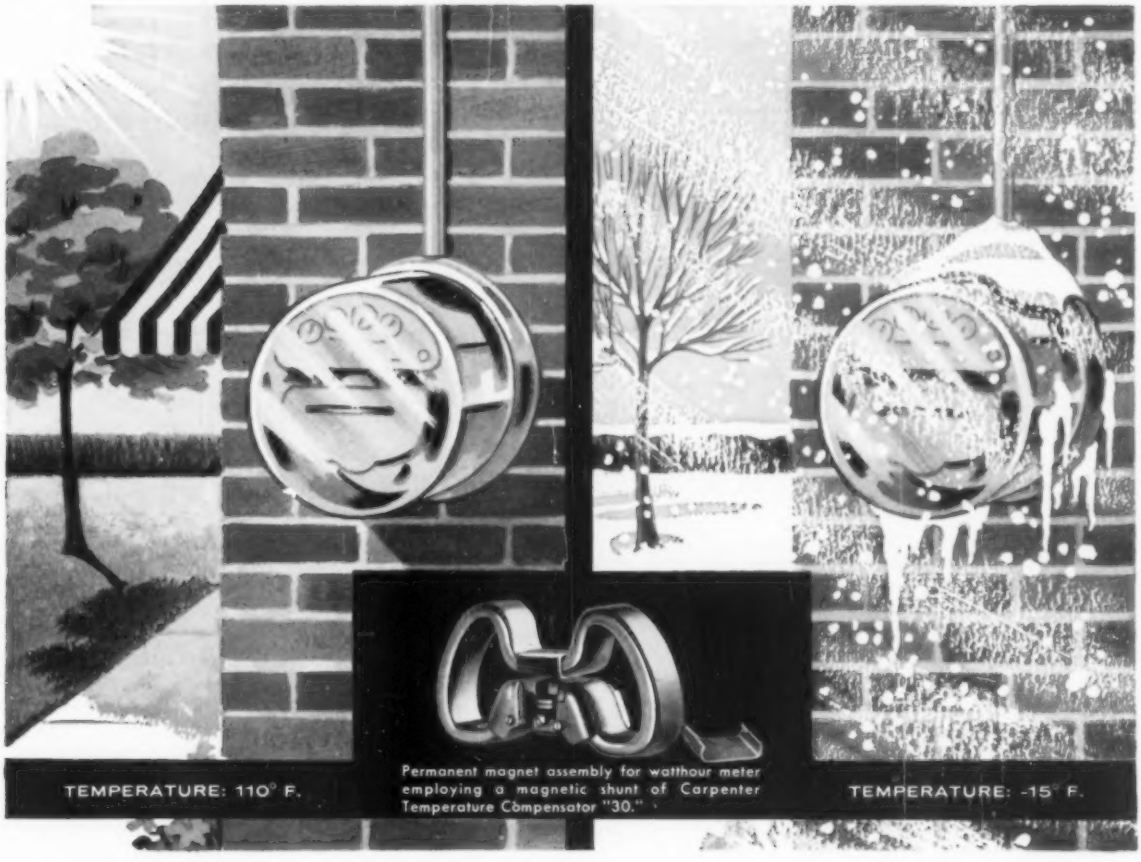
U.S. ELECTRICAL MOTORS Inc. PRE-1
P.O. Box 2058, Los Angeles 54, Calif. or Milford Conn.

☐ *Send Varitrol Automation Booklet No. 1882*
☐ *Send U.S. Varidrive Booklet No. 1797*

NAME _____
COMPANY _____
ADDRESS _____
CITY _____ ZONE ____ STATE _____

U. S. VARIDRIVE
WITH VARITROL®
AUTOMATION WITH VARIABLE SPEED

Carpenter... pioneering in improved Tool, Alloy and Stainless Steels through continuing research


TEMPERATURE: 110° F.
Permanent magnet assembly for watthour meter employing a magnetic shunt of Carpenter Temperature Compensator "30."
TEMPERATURE: -15° F.

When Precision Equipment Must Behave at Varying Temperatures...

Take Advantage of *Carpenter* High Nickel Alloys!

A specially-engineered steel in Carpenter's complete line of high nickel alloys is guarding the accuracy of watthour meter performance in all kinds of weather. Its use covers a wide range of electrical equipment such as watthour meters, voltage regulators, speedometers and aircraft tachometers.

This alloy, Carpenter Temperature Compensator "30", is produced by specialists under strict quality controls. It is another example of how Carpenter's pioneering role in producing *specialty* steels to meet *special* applications works for you in your effort to build better products at a reasonable cost.

And Temperature Compensator "30" is but one of many Carpenter specialties. Other "extremely sensitive" alloys in this line respond to very weak electrical currents . . . permitting you to design smaller, lighter weight units. Still another Carpenter High Nickel Alloy assures precision product performance with practically no size change through temperature ranges up to 400°F.

Take this step for product improvement, now: Write on your company letterhead for detailed information on Carpenter Temperature Compensator, Low Expansion, High Permeability and Glass Sealing Alloys in such forms as strip, wire, bars, tubing and forging billets. *The Carpenter Steel Co., 117 W. Bern St., Reading, Pa.*

Carpenter STEEL

high nickel alloys

Export Department: The Carpenter Steel Company, Port Washington, N. Y.—"CARSTEELCO"

A SPECIAL REPORT ON PROTECTIVE FINISHES FOR ALUMINUM

Most aluminum producers and fabricators are well aware of the superiority of chemical finishes over anodizing for the protection of aluminum from corrosion. Naturally, then, there is a running battle for acceptance among the leading producers of the protective chemical finishes.

That's why, here at Allied, we have always studied your needs with regard to both our own and competitive processes. We're constantly trying to produce new and better finishes because we believe there's always room for improvement . . . even to our own products. Some years ago this policy led to the introduction of a process, long in development, that offered you a way to overcome anodizing's obvious technical complications . . . Iridite #14. This finish was far easier to use than anodizing, yet provided comparable, if not superior, quality. And, its cost was much less than anodizing.

But other finishes offering similar advantages over anodizing have entered the market. So . . . the current battle for acceptance. By any cost comparison Iridite #14 is the most economical. However, corrosion tests by users show contradictory results as to performance from Iridite #14 and other leading protective finishes for aluminum. Most tests show Iridite #14 superior, but some do not. The margin of difference, however, is always small. The truth is that all have proved good. However, our laboratory research indicated that still further improvements could be made.

That knowledge . . . plus our aim to give you even better protection and maintain the leadership of the industry, is exactly why Allied Development Engineers have been working for long years to develop a better finish than any of those now available, including our own Iridite #14.

Now the new finish is ready for you. It's called Iridite #14-2 (Al-Coat).

From a performance standpoint, Iridite #14-2 gives you two important advantages in the protective finishing of aluminum.

FIRST: in its fully colored brown film stage it provides corrosion resistance decidedly superior to previous processes.

SECOND: the basic brown film can be hot water bleached to produce a clear-type film with protection heretofore unobtainable from clear-type chemical finishes.

From an operating standpoint, new Iridite #14-2 gives you three important advantages.

FIRST: it provides consistently higher corrosion resistance for different aluminum alloys treated in the same bath.

SECOND: it provides a more uniform appearance for parts of different alloys and with varied surface finishes before treatment.

THIRD: its operating and technical characteristics are superior to those of other processes.

If you are using or planning to use a chemical finish for aluminum, you should have full details on new Iridite #14-2. Write us or send samples for free test processing. Or, for more immediate advice, call your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified telephone book. - - - ALLIED RESEARCH PRODUCTS, INC., 4004-06 EAST MONUMENT STREET, BALTIMORE 5, MARYLAND.

P. S. Even new Iridite #14-2 will be constantly measured against both your needs and competitive processes to make sure you get the best possible, most economical finish for your product that man and the laboratory can develop.

Easy-to-Apply CaPlugs Give "Kid Glove" Protection to Products in Process, Storage and Transit

Amazing multi-purpose closures of tough, flexible Polyethylene protect tubing, threaded fittings and machined parts

Buffalo, N. Y. (JC) Providing "kid-glove" protection for a tremendous variety of products, over 300,000,000 CaPlugs were used by thousands of industries before their 7th birthday. Extremely easy to apply, these adaptable closures are installed with impressive regularity on tubing, fittings, valves, hydraulic components and numerous machined parts.

Molded of flexible Polyethylene, CaPlugs are exceptionally tough . . . yet most kind to threads and polished surfaces. They are impervious to most common chemical reagents, acids and solvents . . . will not collapse, chip, break or shred.

6 STANDARDIZED DESIGNS . . .
OVER 200 STOCK SIZES

TAPERED CaPlugs

EP & EC Caps and Plugs for Electrical Connectors & Receptacles

CD Threaded Seal and Shipping Caps

PD Threaded Plugs

SC Tubing Sleeve Caps

Threaded Pipe Plugs

Push them in . . . or push them on

TAPERED CAPLUGS can be used as caps or plugs, inside or outside of threaded or plain fittings. Time studies show that these versatile closures save up to 500% in labor costs.

MULTITUDE OF USES

- Dust Caps
- Pipe Caps
- Thread Protectors
- Tube Hole Protectors
- Valve Caps
- Oil Hole Covers
- Pipe Plugs
- Shipping Protectors
- Masking for Plating, Spray Painting, etc.
- Oil, Grease and Dust Seals
- Tubing Seals
- Sales Appeal

Scores of users stress CaPlugadvantages

". . . can be more readily installed than the protectors that we formerly used."
Scintilla Magneto Division

". . . features which interest us most: (1) Protection from damage to threads (2) Prevention of dirt entry (3) Price benefit (4) Appearance (5) Ease in installation (6) Easy removal after use."
A-P Controls Corporation

". . . they also help impress the customer with the steps that have been taken to protect the equipment."
Stewart-Warner Corporation

"They are much easier to install and consequently effect a considerable saving in installation man hours."
Lear, Inc.

"They offer an inexpensive, efficient, and secure source of protection . . . and are easily applied and removed."
Taylor Instrument Companies

Free "see-for-yourself" assortment mailed on request

CAPLUGS DIVISION, PROTECTIVE CLOSURES CO., INC.
2205-9 Elmwood Ave., Buffalo 23, N. Y.

MAIL a free assortment of CaPlugs, literature and prices to us immediately, without obligation.

Name_____ Title _____

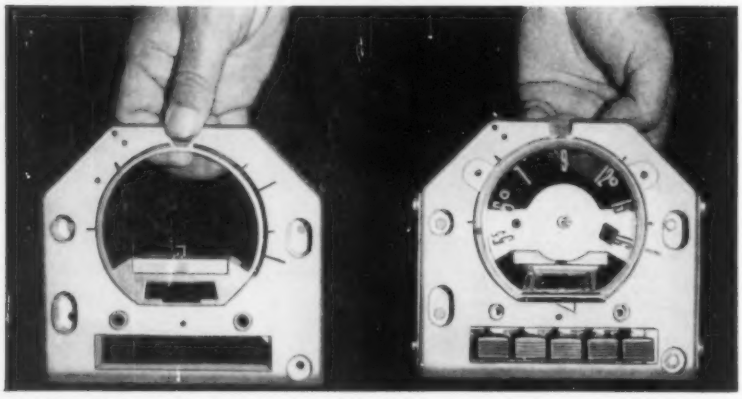
Firm _____

Address _____

City _____ Zone ____ State _____

DIE CASTING REPORT

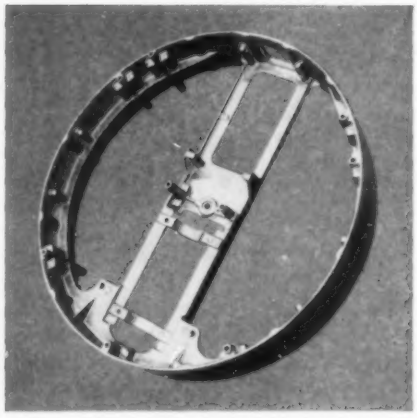
Half a million---or a few hundred ---designing parts for die casting can pay off big!

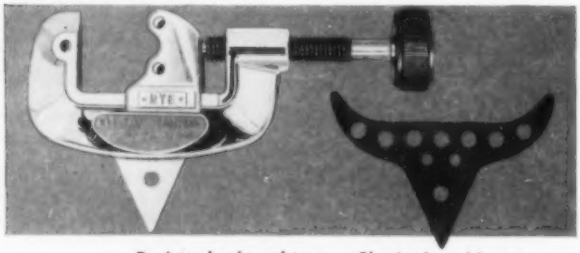


Radio Dial Housing: Production better than half a million. Features: thin walls and cast retaining grooves for close fit. Non-corrosive zinc alloy. Mounting bosses, normally welded on steel, are integral. Accurate cored recesses for tone control.

Aluminum dial support: Annual production in the low thousands, but die casting this unit saved weight, assembly time and machining. As an integral part of every scale, design changes are few; parts can be ordered from standing die, as needed.

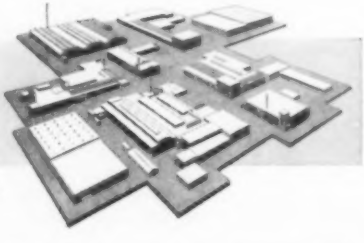
Low production items, as well as those in the millions are often economical to die cast. What is the yardstick? There are many. Costs may be cut and production profits increased where intricate design and difficult contours may be impractical by other means. Die casting may save on machining; eliminate component parts and thus cut down assembly; provide more economical type of surface for plating. No matter what your production schedule may call for —investigate die casting before you decide. Let Precision engineers show you what can be done in aluminum, magnesium and zinc to lower your costs!





Resists shock and torque: Plumber's tool features perforated steel insert in zinc alloy frame. Production several thousand. Result: maximum strength, functional design at minimum cost. Chrome plating adds to wear resistance and sales appeal.

Look for these two symbols when you deal with a die casting supplier. They are your assurance of quality castings and high production standards. Precision is a pioneer member of the American Die Casting Institute and one of the founders of the Certified Zinc Plan.



PRECISION CASTINGS CO., INC.

A SUBSIDIARY OF **Harrisburg Steel** CORPORATION

FAYETTEVILLE, N. Y.—SYRACUSE, N. Y.—CORTLAND, N. Y.—NEW YORK, N. Y.
CHICAGO, ILL.—CLEVELAND, OHIO—KALAMAZOO, MICH.

only

CLEARPRINT Tracing Paper

does so many things so well!

For the perfect working surface, for ghost-free prints, for proven stability - Clearprint Technical Paper has no equal. Since its introduction in 1932, other paper makers have strived to duplicate Clearprint's quality. None has succeeded. Your drawings deserve this superior paper. Insist on genuine Clearprint, *watermarked* for your protection.

THERE'S A CLEARPRINT PAPER FOR EVERY JOB

Tracing Paper · "Papercloth"
Technichart Graph Papers
Federal Aid Sheets
"Fade-Out" Grid Paper

IN SHEETS, PADS and ROLLS

YOU BE THE JUDGE...

Make this simple

CLEARPRINT TEST

1. INVITES PENCIL AND PEN —

Try Clearprint's perfect working surface with a 2H pencil, then with a ruling pen. Lines are sharp and clean — no feathery edges.

2. NO GHOSTING —

Erase some of the lines. Redraw and erase several of them repeatedly. Crease the paper, too. Then hold it to the light, or make a reproduction. Seeing is believing!

3. NEVER CHANGES —

Sheets in use since 1932 prove Clearprint does not tear or become "dog-eared" in the files. Its strength, transparency and printing qualities remain unchanged after extended exposure to age, atmosphere, heat and light.

Make this test, too, on the paper you are now using. The difference will convince you.

CLEARPRINT®

TECHNICAL PAPER

THERE IS NO SUBSTITUTE
Demand Watermarked Clearprint

SEEING is BELIEVING!

Ask your dealer for samples, or send coupon

3

CLEARPRINT PAPER CO. (PE)
1482 - 67th St., Emeryville, Calif.

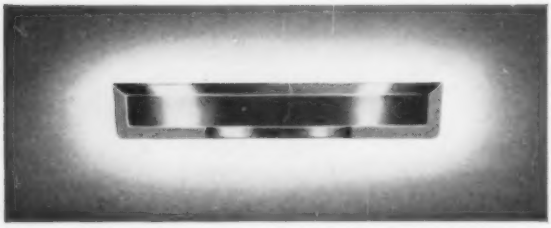
☐ Please send me Clearprint Paper samples, with prices, for the following uses:_____

☐ Please have your representative call at my office.

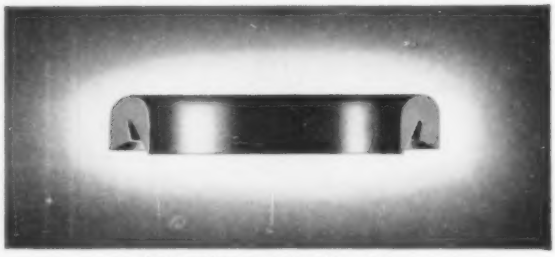
Name_____
Firm_____
Address_____
City_____ Zone____ State_____

Simplify your sealing problems...

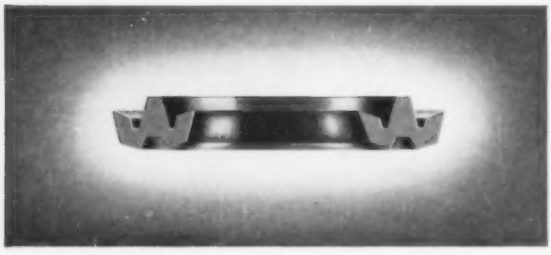
with Johns-Manville Precision moulded packing designs for pressure applications in hydraulic and pneumatic equipment



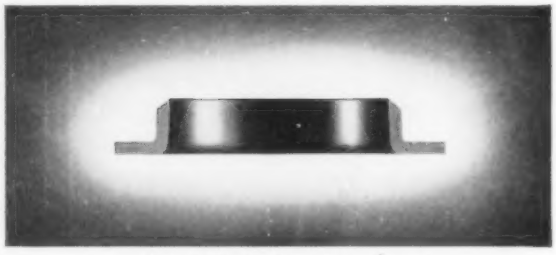
1. Type "A" Packing Cups for pistons
(the original "square heel" cup design)



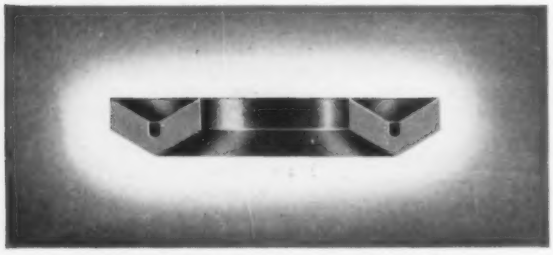
2. Sea Ring packing for rods



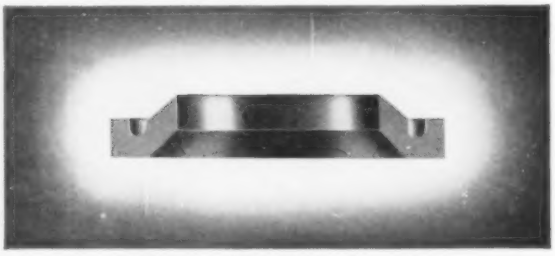
3. Uneepac Packing for rods and pistons



4. Hat Cup Packing for rods



5. V-Rings packing for rods and pistons



6. Cumpac #239 packing for rods

7. U-Cup Packing for rods and pistons

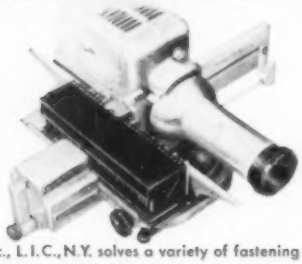
THE WIDE VARIETY of Johns-Manville Packing designs enables you to handle practically any sealing problem. The designs shown on this page are obtainable in a broad range of standard sizes and in materials designed for either usual or special service conditions encountered in hydraulic and pneumatic equipment. Johns-Manville also produces oil seals, moulded gaskets and miscellaneous shapes to specification. See your local J-M distributor or J-M sales office for product or engineering data. Or write Johns-Manville, Box 60, New York 16, N.Y. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville MOULDED PACKINGS

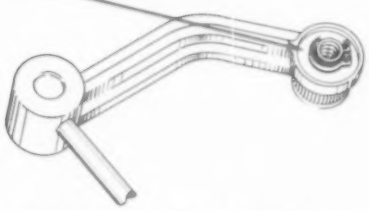
Waldes Truarc Rings Permit Better and More Economical Design—Fewer Parts, Faster Assembly, Minimal Rejects!

Viewlex's Change-O-Matic



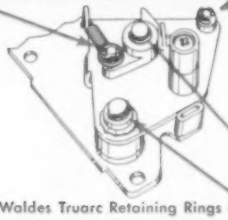
Viewlex, Inc., L.I.C., N.Y. solves a variety of fastening problems in their new model Change-O-Matic automatic slide changer. Assembly time is speeded, parts eliminated, rejects lowered, and compact, economical product design achieved.

Connecting Arm Assembly



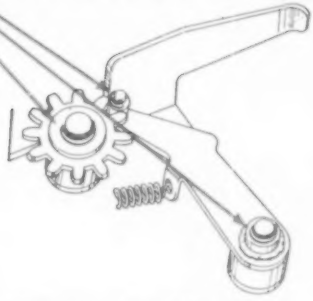
Use of one Waldes Truarc Ring (Series 5100) eliminates time-consuming riveting over the flange, retains and holds the connecting knob captive. A compact, neat design is made possible, rejects caused by poor riveting eliminated.

Actuating Plate and Pawl Assembly



Three types of Waldes Truarc Retaining Rings are used in this assembly. One circular self-locking ring (Series 5103) retains pawl return spring. One external E-ring (Series 5133) retains roller used to prevent gear motion during transport cycle. One crescent ring (Series 5103) retains pawl which indexes gear. Second crescent ring retains sub-assembly. Truarc Rings speed assembly, cut rejects, eliminate parts.

Detent Lever Assembly



Truarc E-ring (Series 5133) eliminates use of tapped hole and shoulder screw, retains roller which prevents over-travel of gear. Assembly is rapid.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool!

Send for new catalog supplement

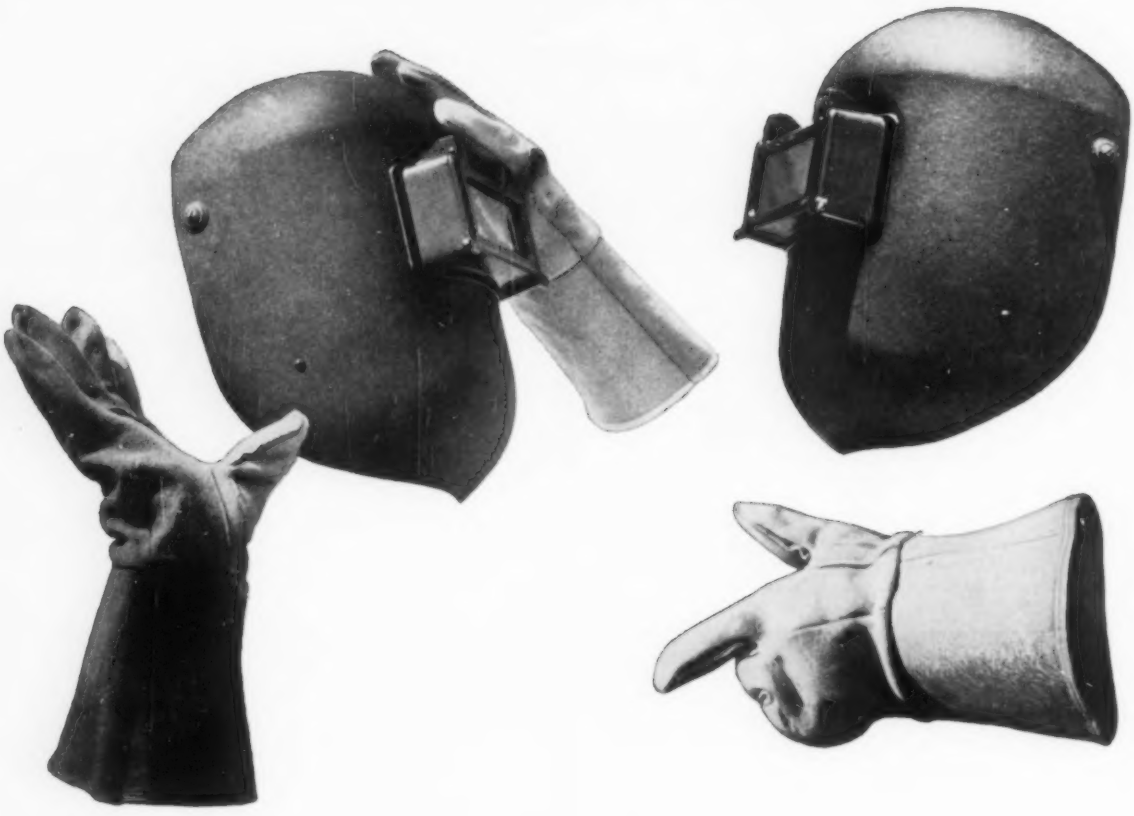
WALDES TRUARC® RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

Name _____
Title _____
Company _____
Business Address _____
City _____ *Zone* ___ *State* _____

PH018

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.



WHAT—*HANDLES LIKE CARBON STEEL?*

That's right. Worked with the same techniques as carbon steel, Lukens "T-1" steel can be readily welded without special joint designs or procedures.

Although Lukens "T-1" steel is a tough, high strength, heat treated steel, designers and engineers will find that its ready weldability and excellent wear characteristics will pay off in design freedom and increased equipment efficiency. Because this low carbon, quenched and tempered steel poses no unusual problems in welding, equipment can easily be fabricated, modified or repaired not only in the shop but also in the field. Three times stronger than carbon steel, this new steel has lighter weight and reduced thickness in comparison to heavier, thicker plates of carbon steel, thereby reducing material, construction and shipping costs.

Lukens' range of steel plate sizes—including the widest and heaviest plates available anywhere—makes possible additional savings through the use of wider plates that require fewer welded seams. Lukens "T-1" steel's resistance to the combination of wear and impact abuse lowers maintenance and replacement costs, lengthens equipment life.

The latest addition to Lukens' complete line of carbon, alloy and clad steels, this new steel's unusual combination of properties suit it especially to applications in pressure vessels, bridges, shipbuilding, construction machinery and general industrial equipment. On problems of design, material selection, application and fabrication techniques, Lukens offers full technical assistance. If you would like further information on Lukens "T-1" steel, write to: Manager, Marketing Service, 775 Lukens Building, Lukens Steel Company, Coatesville, Pennsylvania.

LUKENS

"T-1" STEEL

To get the new, 28-page book on Lukens "T-1" steel, ask for Bulletin 781.

THE NEWEST IN A COMPLETE LINE OF ALLOY STEELS

LUKENS STEEL COMPANY, COATESVILLE, PENNSYLVANIA

THERMALLY BALANCED...

to Prevent Crazing

OHMITE®

"Brown Devil"® RESISTORS

Ohmite "Brown Devil" Resistors have been carefully designed to provide *balanced thermal expansion.* All parts—core, resistance wire, vitreous enamel coating, and terminal band—have a thermal expansion that has been carefully matched. Consequently, Ohmite "Brown Devil" Resistors expand and contract as a unit. This eliminates cracking of the enamel, keeps terminals firmly anchored, and prevents the entrance of moisture.

THE RESULT: You are assured high-quality resistors that provide the utmost in dependability under the toughest service. Specify Ohmite "Brown Devils" on your next job.

They Last Longer!

1 PATENTED WELDED TERMINALS
Ohmite welded terminals provide a perfect and permanently stable electrical connection that is unaffected by vibration or high temperature.

2 HIGH TEMPERATURE STEATITE CORE
This strong, rugged, steatite core has excellent electrical characteristics, and a coefficient of thermal expansion that matches the other resistor materials.

3 EXCLUSIVE HIGH TEMPERATURE VITREOUS ENAMEL
This special-formula enamel was developed by Ohmite after extensive research. Its thermal expansion is properly related to that of the steatite core, terminal, and resistance wire.

Be Right with OHMITE®

OHMITE MANUFACTURING COMPANY, 3611 Howard Street, Skokie, Illinois (Suburb of Chicago)

RHEOSTATS · RESISTORS · RELAYS · TAP SWITCHES

WON'T CHAR OR BURN!

OHMITE® HIGH CURRENT ROTARY TAP SWITCHES

ALL-CERAMIC AND METAL

Ohmite rotary tap switches are preferred by industry everywhere because they are compact, dependable, all-ceramic and metal units ideally suited to a-c operation. They are available in the single-pole, non-shorting type with up to 12 taps. The self-cleaning, silver-to-silver contacts require no maintenance. The rugged, one-piece ceramic body is unaffected by heat or arcing. Two or three of these switches can be grouped in tandem to form multi-pole assemblies. Open-type models are also available for shorting and non-shorting applications.

Write on company letterhead for Catalog and Engineering Manual No. 40.

OHMITE MANUFACTURING CO.
3611 Howard St., Skokie, Illinois
(Suburb of Chicago)

Be Right with

OHMITE®

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES

5 SIZES

AC RATINGS

AMP	VOLTS	NO. TAPS
10	150	2 to 11
15	150	2 to 12
25	300*	2 to 12
50	300*	2 to 12
100	300	2 to 8

*150 Volts between taps.

Taking the noise out of sound

With movable wall panels, like those pictured above, you can build a room anywhere—in the factory, in the office, in the laboratory. But the new room would be impractical unless it were protected from outside vibration and noise. That's where 3M comes in.

EC-1000 is a vibration and sound damping coating that withstands high temperatures directly after application. Immediately after EC-1000 is sprayed on the back side of the metal panels, they are primed and run through the baking ovens! There's no lost motion . . . no production line slowdown. And once installed, walls treated with EC-1000 make a room that is quieter, easier to work in, relatively unaffected by external noise and vibration.

See what adhesives can do for you...

Perhaps you have a production problem 3M can help you solve. A 3M field engineer will be glad to consult with you on your specific requirements. Or, for a free booklet on cost-cutting 3M adhesives, write 3M, Dept. 41, 417 Piquette Ave., Detroit 2, Mich.

3M COMPANY

ADHESIVES AND COATINGS DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

417 PIQUETTE AVE., DETROIT 2, MICH. • GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 122 E. 42 ST., N. Y. 17, N. Y. • CANADA: LONDON, ONT.

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND-RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS

GENERAL CONTROLS

MANUFACTURERS OF AUTOMATIC CONTROLS FOR HOME, INDUSTRY AND THE MILITARY

GENERAL CONTROLS • PERFEX CONTROLS

40 FACTORY BRANCH OFFICES SERVING THE UNITED STATES AND CANADA

FIVE PLANTS: IRON MOUNTAIN, MICHIGAN • GLENDALE, CALIFORNIA • BURBANK, CALIFORNIA • SKOKIE, ILLINOIS • GUELPH, CANADA

Write for free catalogs: Heating, Refrigeration, Industrial and Hydramotor. Address General Controls Co., 801 Allen Avenue, Glendale 1, California.

SLOW OPENING GAS VALVES

New combustion control afforded by these diaphragm-controlled gas valves. Governor regulates fuel supply to burner in direct ratio to steam pressure, eliminating hunting aspect common to most piloted throttling valves. Low fire adjustment prevents main valve or gas flow from reducing below adjustable set minimum, affording fullest advantage of gas burner installed. Type B-55-G, pictured, available 1" to 6" I.P.S.

MAGNETIC PILOTED PISTON VALVES

Two-wire, current failure, high pressure. Designed to handle large capacities with minimum pressure drop. Main valve held open electrically minimizing pressure loss. Packless construction. Normally closed; operates efficiently on wide variety fluids and gases. A.C. or D.C. Manual opening device optional; seat and seat rings or discs removable. Type K-15 is pictured.

MAGNETIC LEVER VALVES

General Controls' K-10 has six times more powerful lever action than ordinary solenoid valves. Quiet, two-wire, current failure, packless construction. Handles air, gas, water, light and heavy oils, steam. Positive opening, complete shut-off. Designed for either normally closed or open; A.C., D.C., up to 1¼" I.P.S., port sizes up to 7/16".

MAGNETIC GAS VALVES

Magnetic, current failure, quiet, two-wire. Opens and closes fuel line supply at demand of room thermostat, limit control or similar device. Widely used for controlling gas to warm air furnaces, gas fired boilers, industrial furnaces, conversion burners, etc. Compact; low current consumption; humless, ⅜" to 6" I.P.S. for pressures up to 5 lbs. A.C. or D.C. Standard solenoid pictured. Also available in explosion-proof model.

WARM AIR CONTROL

This type of warm air control is operated by a bimetal helix and is available in three models for three distinct functions, i.e.: a high limit control, a fan control and a duct fire protection control.

GAS FUEL GOVERNORS

Will throttle gas lines according to boiler pressure applied to diaphragm. Ball bearing thrust, adjustment, ground and polished non-corrosive stems, low-friction packing gland seal, multiple calibrated springs; high lift for maximum capacity. Suitable for butane, natural or manufactured gas. Available ⅜" to 3" I.P.S. Type V-25 pictured.

THERMOSTATS

T-70 Thermostats distinguished by compactness and beauty of appearance—for use in all space heating remote control systems. Provide rapid response to radiant as well as convected heat. Snap-action or mercury switch type thermostat with operating differential adjustable between 1¼° and 3°F. Heat Anticipator optional. Line voltage types to 13 amperes are available for heating and cooling.

LOW WATER CUT-OFFS

Electric, free of moving parts, glands or seals under pressure. Small-volume electrode chambers. Line voltage and motor capacity models carry double voltage coils, permitting 115 or 230 volt A.C. connections. Low voltage models available on all types. All electrode voltages low; electrode insulators field-proven to withstand action of steam and water under pressure. Chambers and fittings for pressures up to 150 lbs. A.C. only.

HYDRAMOTOR VALVES

H-1 to H-3 Series simplify many control installations. Two-wire, current failure, electric-hydraulic operation. Ample motor-driven power; slow opening and closing. Operator drives against a spring in one direction. Power failure or opening of circuit causes spring to operate other direction. H-1 series designed for usual commercial, small industrial valves; H-2 Series, commercial, industrial; H-3 Series, industrial piston types.

THERMAL EXPANSION VALVES

Type V-200 Thermal Expansion Valves (pictured) provide unmatched sensitivity and dependability. Quickly adjusted orifice cartridge eliminates need for stocking several sizes for low tonnage installations. Valve may be installed in any position. Handles freon, methyl chloride, sulphur dioxide. Factory set superheat 10 degrees F.

MANUAL RESET VALVES

Equipped with manually-reset electromagnetically-held valve operator. Current flowing to operator permits manual opening. Current failure releases operator allowing valve to close. Safety feature is trip-free mechanism which cannot be opened. Once closed, valve is unaffected by applying current; must be reset manually. ½" to 6"; normally closed; screwed or flanged body; explosion-proof or weather-proof. Type V-110-1 pictured. Factory Mutual and Underwriters Approved.

DRAFT GAGE

DRAFT GAGE measures the suction (draft) in various chambers, ducts and tubes. In efficient boiler operation, the gage is used to measure either draft in the firebox or boiler outlet draft to guide the operator in maintaining close control of the burning fuel.

GAS SAFETY AND PILOT BURNER

The combination of the gas cock safety shut-off valve and the new type pilot burner provides the ultimate in 100% safety and low fuel consumption while fulfilling the requirements of positive heat control. Both units represent the maximum in precise engineering.

RELAYS AND TRANSFORMERS

Type RS-100 Relays handle single phase motor loads up to 1 H.P. or heating loads up to 1.1 K.W. Combine double break relay and integral transformer. Normally open; large double break contacts prevent contact trouble. Two-wire control circuit; maximum holding current 0.4 amps. ½" conduit connections; low voltage outlet. A.C. only.

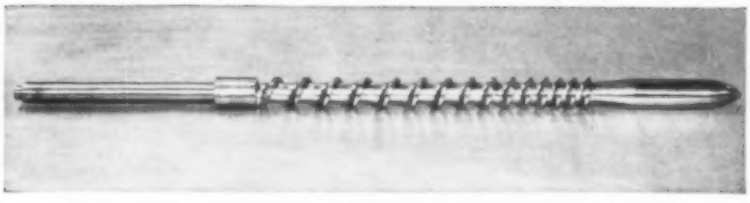
DOW

Plastiatrics

DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION

PLASTIATRICS HELPS YOU CHOOSE AND USE PLASTICS CORRECTLY

Are you getting the most out of the plastics you need? Do you have the best or the latest for your money? Are you satisfied that plastics are right for the job? That's where *Plastiatrics* comes in . . . to provide a continuous study, analysis and treatment of plastics . . . to understand, prevent or cure plastics problems. Dow, which produces polystyrene under the trade name Styron®, conducts studies in many fields of plastics. For example, continuing studies are undertaken on extrusion. These are of significance to engineers and plastics molders.



DOW'S STUDIES ON IMPROVED SCREW AND TORPEDO DESIGN HELP MAKE POLYSTYRENE EXTRUSION A MORE EXACT SCIENCE

Studies for the development of a better screw and torpedo from polystyrene extrusion are good examples of Plastiatrics at work. Manufacturers using machines equipped with a single flight screw and torpedo arrangement like this one shown here can profitably extrude high-quality polystyrene and get uniformly good results. One thing that was found in working out the details of this better screw was that single flight eliminates blocking in one channel and flowing in another, a problem of the double flight screw that more often than not produces wide variations in product output.

Further studies of the torpedo have led to extensive findings, relative to the use of the torpedo screw, which are available by simply writing Dow.

Standard pressure gage studies another area of Plastiatrics development

Extensive Plastiatrics studies in extrusion have been made on the proper design of dies, take-off equipment and cooling problems. Dow engineers, together with plastics manufacturers, also developed a method for determining optimum pressure and for providing reproducible extrusion performance using a standard gage.

Write for free bulletins

Detailed results of Dow's studies on extrusion are available to you, as they are on all work done in Plastiatrics. For further information, write today . . . Dow Plastics Sales Department PL 456Z, THE DOW CHEMICAL COMPANY, Midland, Michigan.

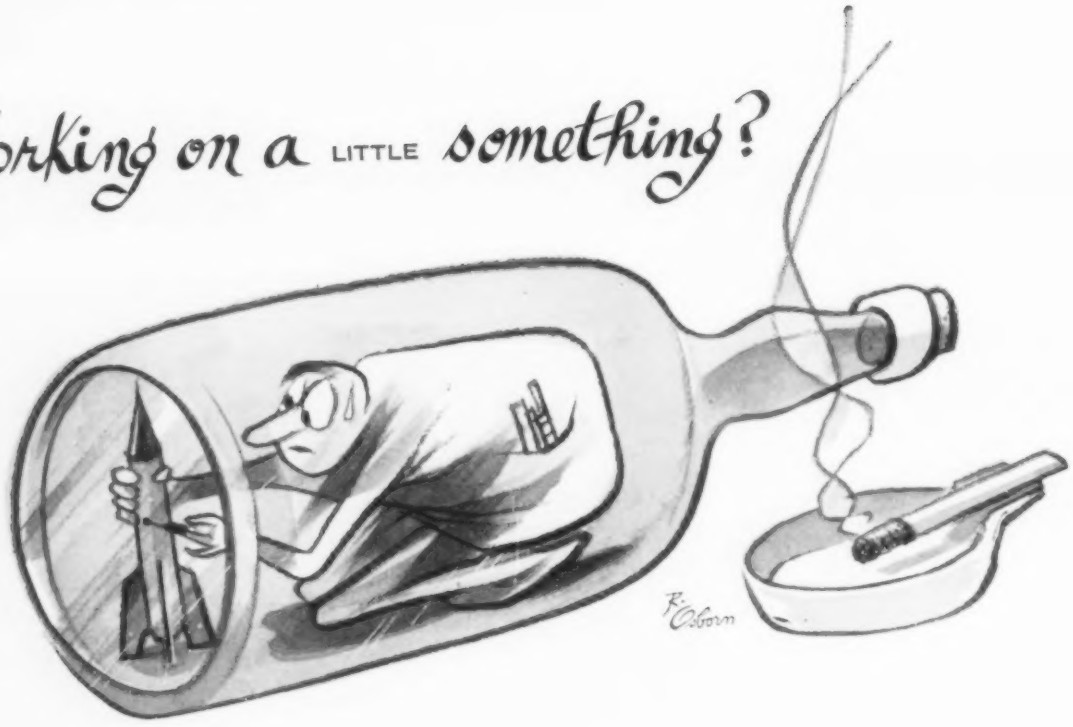
DOW POLYSTYRENE FORMULATIONS:

- Styron® 666 . . . Dow general-purpose polystyrene.
- Styron 688 . . . for controlled flow and controlled pressure distribution in the mold cavity.
- Styron 777 . . . for medium-impact strength.
- Styron 475 . . . for high-impact strength and high elongation.
- Styron 475 sheet . . . for vacuum or pressure forming.
- Styron 480 . . . for extra-high-impact strength.
- Styron 700 . . . for high heat resistance.
- Styron 683 . . . for medium-high heat resistance.

you can depend on DOW PLASTICS

DOW

Working on a LITTLE *something*?



Dont let problems of miniaturization be your bottleneck! Cut coupon for complete catalog describing over 500 types and sizes of MPB's* such as these

BALL BEARINGS ACTUAL SIZE

Miniature Precision Bearings, Inc., 4 Precision Park, Keene, N. H.

YES! Send me your complete new MPB CATALOG

name title company

street city zone state

*MINIATURE PRECISION BEARINGS, INC., KEENE, N. H.

ALLIS-CHALMERS

CONTROL

. . . Backed by Wide Application Experience

As manufacturers of *diversified* industrial equipment, Allis-Chalmers has been called upon to solve control application problems in practically every industry. This specialized experience in coordinating power utilization is *yours* when you specify Allis-Chalmers control.

The Allis-Chalmers line includes control for every condition of motor operation. Functions include full or reduced-voltage starting, acceleration, speed control, reversing or non-reversing, and dynamic braking. Built into Allis-Chalmers control is the type and degree of protection dictated by the application. Controls are available in general-purpose and special enclosures.

A-4587

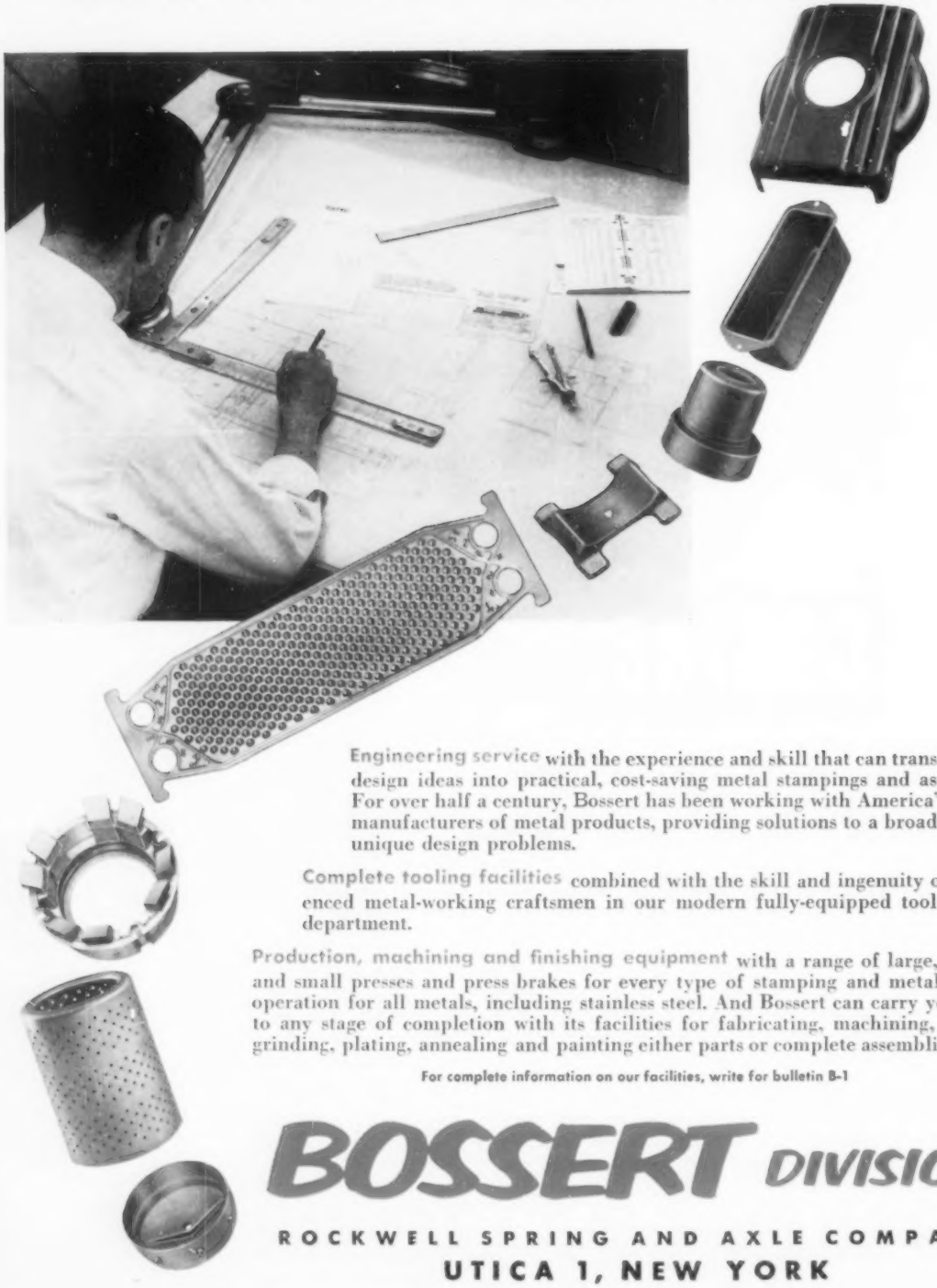
● For help on a specific control application, call your Allis-Chalmers representative. His recommendations are backed by Allis-Chalmers engineering departments . . . by experience gained in solving thousands of control problems . . . by complete research and testing facilities.

ALLIS-CHALMERS

MILWAUKEE 1, WISCONSIN

Designs unlimited...

when you plan your stampings with BOSSERT



Engineering service with the experience and skill that can translate your design ideas into practical, cost-saving metal stampings and assemblies. For over half a century, Bossert has been working with America's leading manufacturers of metal products, providing solutions to a broad range of unique design problems.

Complete tooling facilities combined with the skill and ingenuity of experienced metal-working craftsmen in our modern fully-equipped tool and die department.

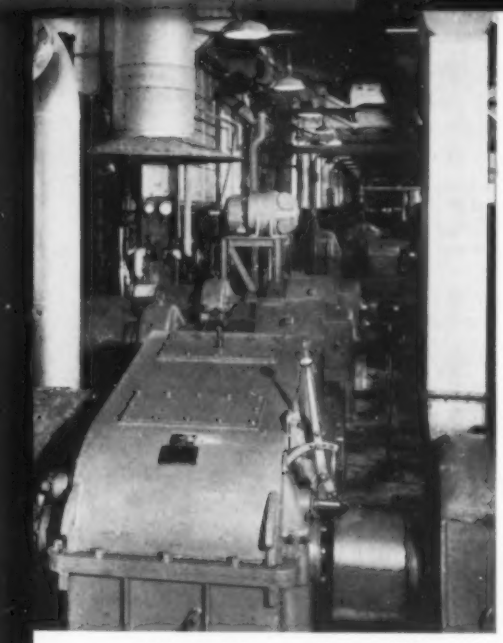
Production, machining and finishing equipment with a range of large, medium and small presses and press brakes for every type of stamping and metal-working operation for all metals, including stainless steel. And Bossert can carry your work to any stage of completion with its facilities for fabricating, machining, welding, grinding, plating, annealing and painting either parts or complete assemblies.

For complete information on our facilities, write for bulletin B-1

BOSSERT DIVISION

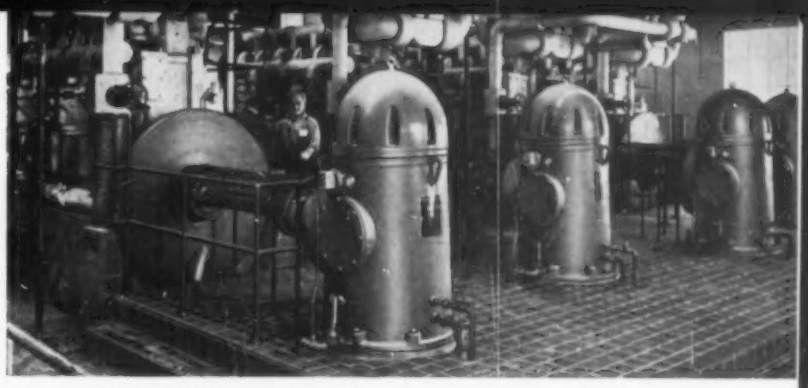
ROCKWELL SPRING AND AXLE COMPANY

UTICA 1, NEW YORK



FORMERLY a prominent mill lost time changing gears for processing heavy grades of Kraft board because of additional drag and increased load which overtaxed the motor. Western Gear solved the problem by installing a two-speed drive with optional ratios of 6.94:1 and 14.04:1 with 400 HP input in either ratio. Gear changes now are made by merely shifting a lever. Man hours were saved and motor overload was prevented.

WESTERN GEAR diesel-engine-driven speed increasers, among the largest ever constructed for U.S. pipeline service, are exclusively used on Mid-Valley's 1,000-mile pipeline. Daily pumping capacity of this huge pipeline has been increased recently by the addition of two new 1800 HP units.



RIGHT ANGLE PUMP DRIVES designed and manufactured by Western Gear shown here installed in the San Diego municipal water treatment plant. Western Gear manufactures a complete line of drives for high horsepower or high speed right angle application.

OUT OF THE CATALOG OR OFF THE DRAWING BOARD

WESTERN GEAR CAN FILL YOUR MACHINERY REQUIREMENTS!

Whatever the application, call on Western Gear engineers for assistance. Their recommendations are based on experience accumulated since 1888 in the design, testing and manufacture of virtually any type of mechanical power transmission equipment. This extensive background in special machinery design and construction ranges from fractional horsepower motors to mammoth marine cable laying devices, from pulp mill machinery to tiny guided missile components and from printing presses to peach pitters.

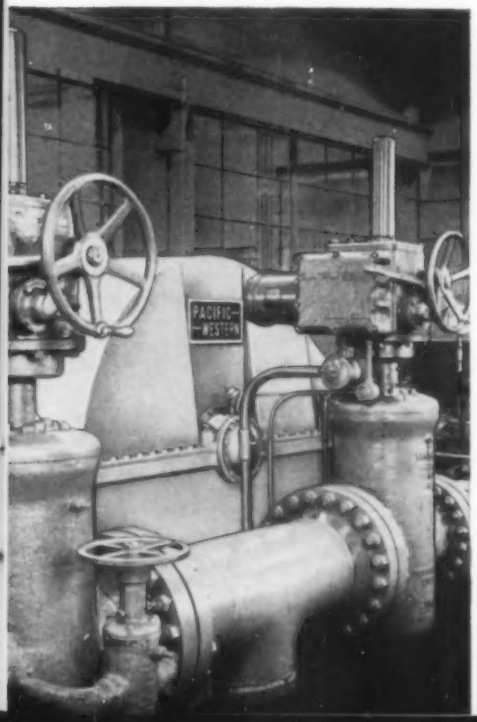
Western Gear skill has contributed to virtually every industry. The experience and knowledge obtained is your assurance of reliability and outstanding performance. For help on your problem, write General Offices, Western Gear Corporation, P.O. Box 182, Lynwood, California.

"The difference is reliability" • Since 1888

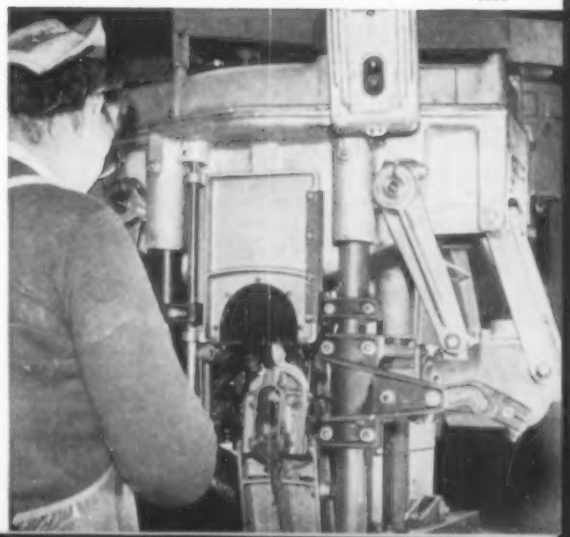
WESTERN GEAR Corporation
ENGINEERS AND MANUFACTURERS

WG

9586



PEACH PITTER which halves and pits cling peaches mechanically, constructed by Western Gear for the Filper Corporation to be used by the Filice & Perrelli Canning Company, a leader in the California fruit canning industry. The Filper process is said to improve both the quality and the yield while it also reduces hand labor.



PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE AND HOUSTON — REPRESENTATIVES IN PRINCIPAL CITIES

New nylaflow* tubing is all these things ...and more!

NYLAFLOW . . . the new POLYPENCO® nylon tubing . . . now permits you to get all the advantages of nylon in pressure lines for lubricants, air, fuel and oil, coolants, process streams, and hydraulic fluids.

With all its superior performance, NYLAFLOW tubing costs less in some small sizes than copper tubing. And it costs much less than flexible rubber hose.

Another thing, NYLAFLOW costs less to install. There's no pre-bending . . . no intermediate fittings . . . no flexible hose attachments. Instead, NYLAFLOW can be run in continuous lengths and connected simply by using a standard metal compression or flare fitting at each end. Because it's flexible and light weight, NYLAFLOW tubing also simplifies prefabrication of tubing assemblies.

NYLAFLOW tubing is now available in stock diameters and lengths. There are two grades: Type T with a tested bursting strength of 1,000 psi; and Type H, 2,500 psi. The tubing also is available in colors for color coding.

SEND FOR NEW *NYLAFLOW* TUBING BULLETIN

THE POLYMER CORPORATION of Penna. • Reading, Penna.

POLYMER *NYLAFLOW* TUBING

. . . nylon . . . Teflon† . . . and other non-metallic shapes

In CANADA: Polypenco, Inc., 2052 St. Catherine W., Montreal, P.Q.

†Teflon is the trademark for DuPont tetrafluoroethylene resin

*NYLAFLOW is the trademark for The Polymer Corporation's nylon tubing

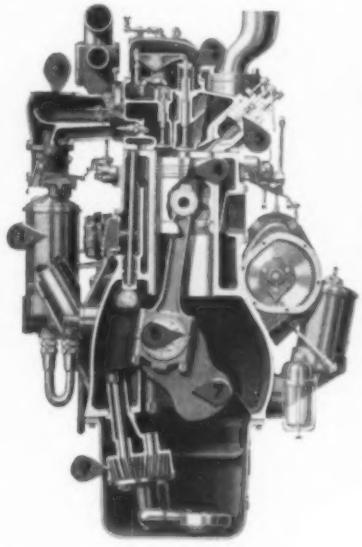
1 FULL FLOW OIL FILTER—Before oil goes under pressure to engine bearings, all harmful particles are removed by replaceable plastic-impregnated, full-flow filters.

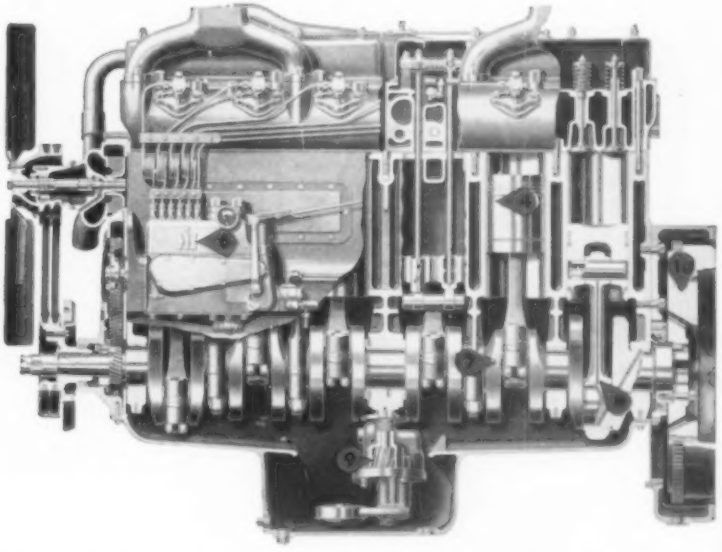
2 POSITIVE ROTATORS EXTEND VALVE LIFE. Exhaust valve rotators keep valves turning, at all engine speeds, distributing heat uniformly around the valves to keep deposits from building up on stems and seats, and also to prevent sticking, scuffing, and burning.

3 POSITIVE ALL-WEATHER STARTING. Seconds-fast, International Diesels start in coldest weather on exclusive gasoline starting system. Cylinders are pre-heat conditioned to give complete, clean combustion, instantly, on switching to operation on Diesel fuel.

4 ALUMINUM-ALLOY PISTONS have a thick crown at the top for rapid dissipation of excess heat direct to the cooling water. Hardened, replaceable, cylinder sleeves, three compression rings, with top ring chrome-plated, plus two oil control rings assure long-lasting, gas-tight seal for high compression ratios of over 15 to 1 . . . providing top fuel and oil economy.

5 SIMPLE, SINGLE-HOLE, INJECTION NOZZLE and pre-combustion chamber set at 45° angle for smooth, clean combustion of low grade No. 2 fuel oil under all engine speed and load conditions.





6 NEW IH INJECTION PUMP: Single plunger type on four-cylinder models, twin-plungers on six-cylinders . . . provide all cylinders equal amounts of fuel, precisely metered to load, whether for idling, maximum horsepower, or maximum torque under overload. New, harder injection plungers have up to four times longer life.

7 HEAVY-DUTY FORGED CRANKSHAFT with large diameter, induction-hardened journals provides long-lasting, wear-resistant bearing surfaces . . . rifle-drilled for full pressure lubrication . . . dynamically balanced for smooth operation.

8 REPLACEABLE TRI-METAL BEARINGS provide precision clearance for full-pressure lubrication and thousands of hours of heavy-duty work. Smooth electroplating of white alloy metal over copper-lead, precision bonded to a steel back, carries heavy loads with minimum friction.

9 FULL-PRESSURE LUBRICATION for long life. Big, gear-type pump delivers oil under controlled pressure through full-flow filters and rifle-drilled passages to main and connecting rod bearings, piston pins, camshaft, timing gears, and valve rocker arms.

10 HEAVY FLYWHEEL helps to maintain uniform speed under widely varying load conditions. Available to match standard makes of clutches, fluid couplings, and torque converters.

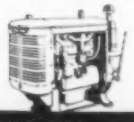
Hour after hour. . year after year

INTERNATIONAL ENGINES

. . . stay on the job with least upkeep

All International engines are built throughout to give you a full measure of power that stands up and stays on the job. They are precision-manufactured of thoroughly tested materials under continuous, quality-control inspection. Pressure lubrication through rifle-drilled crankshafts and internal passages assures trouble free performance. Inbuilt precision is fully protected from dirt and grit under the worst of job operating conditions by the best of fuel, oil, and air filters.

Heavy-duty radiators, power take-offs, and other factory-engineered power unit components are available to fit these long-life, money-saving engines to your job requirements. You can also get them as original equipment in most makes of construction machines. Call your nearest International Industrial Power Distributor or Power Unit Dealer for all the facts.



There's a size and type of International engine to fit your needs . . . from 16½ to over 200 hp.

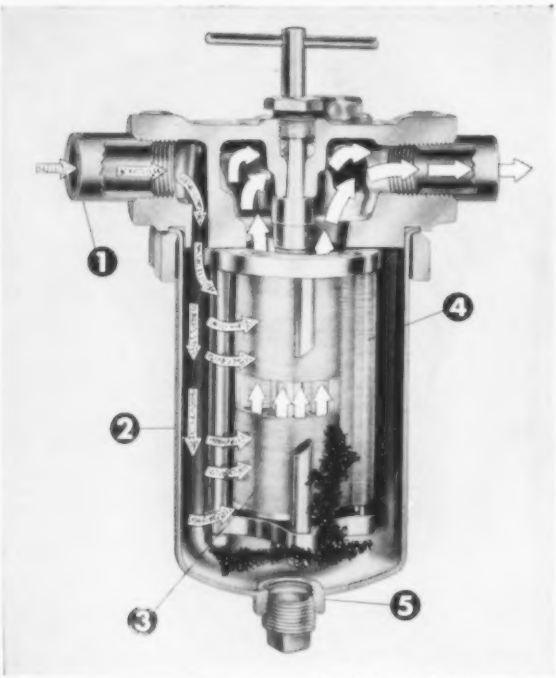
INTERNATIONAL HARVESTER

INTERNATIONAL
INDUSTRIAL POWER

MAKES EVERY LOAD A PAYLOAD

NOW! 40-micron, self-cleaning filter

It's the new Cuno SUPER Auto-Klean



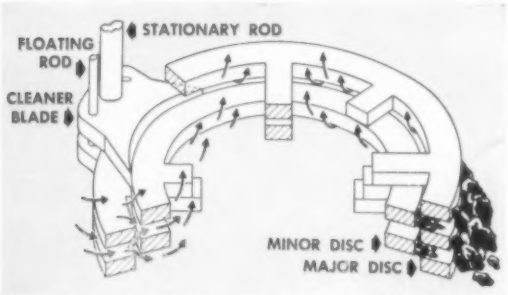
HOW IT WORKS. Dirty oil enters inlet (1) at left, fills housing (2) and flows through metal edge-type filter (3). Clean oil rises through center of filter, leaves at right. Dirt combed out by cleaner blades (4) is removed through drain (5).

Cuno's new SUPER Auto-Klean is the first practical, compact micronic filter for lubricating oil, hydraulic fluid, coolant, fuel, and other industrial fluids.

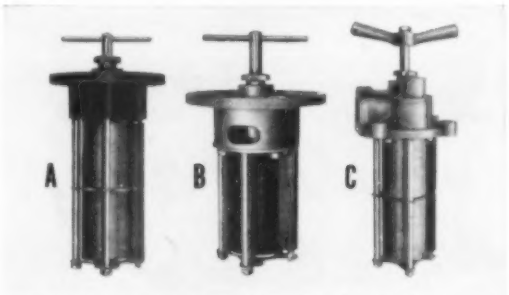
Many times smaller than other micronic filters of equal capacity, Cuno's new SUPER Auto-Klean filter now makes possible economical, micronic filtration at high flow rates and eliminates the need for replacement cartridges in most cases. Here's what it offers:

1. **Full-flow** 40-micron filtration with a self-cleaning filter. Positive protection against particles larger than 40 microns (actually 0.0015 in.). All-metal filter can't rupture or channel.
2. **Easy cleaning.** Just turn the handle—by hand or continuously with motor drive. No interruptions for cleaning.
3. **No cartridge changes.** Ends operating costs if you've been using cartridge filters.
4. **Low pressure drop, no pressure drop build-up.** An 8" by 2¾" SUPER Auto-Klean filters 30 gpm of 200 SSU oil with only 3 psi pressure drop—up to 75% more with slightly higher pressure.
5. **High capacity in a small package.** Many times smaller than replaceable-cartridge type filters of equal capacity, it saves with lower initial costs, lower installation costs.
6. **Easy to build into new equipment.** Available for line-type housings *(left)* or incorporation in sump or reservoir *(below.)* Works in any position.
7. **Easy to install in old equipment.** Fits existing Auto-Klean housings. You can easily replace most 2¾" diameter elements with SUPER Auto-Klean for finer filtration.

Write today for complete technical data on the new SUPER Auto-Klean for your new or existing equipment. Ask for Catalog No. SAK-057. Cuno Engineering Corporation, 20-1 South Vine Street, Meriden, Connecticut. 59



FILTER ELEMENT consists of stacked major and minor discs and cleaner blade bearing against minor discs. Small arrows show flow. Short restrictions between minor and major discs stop 40-micron particles but allow high flow rate.



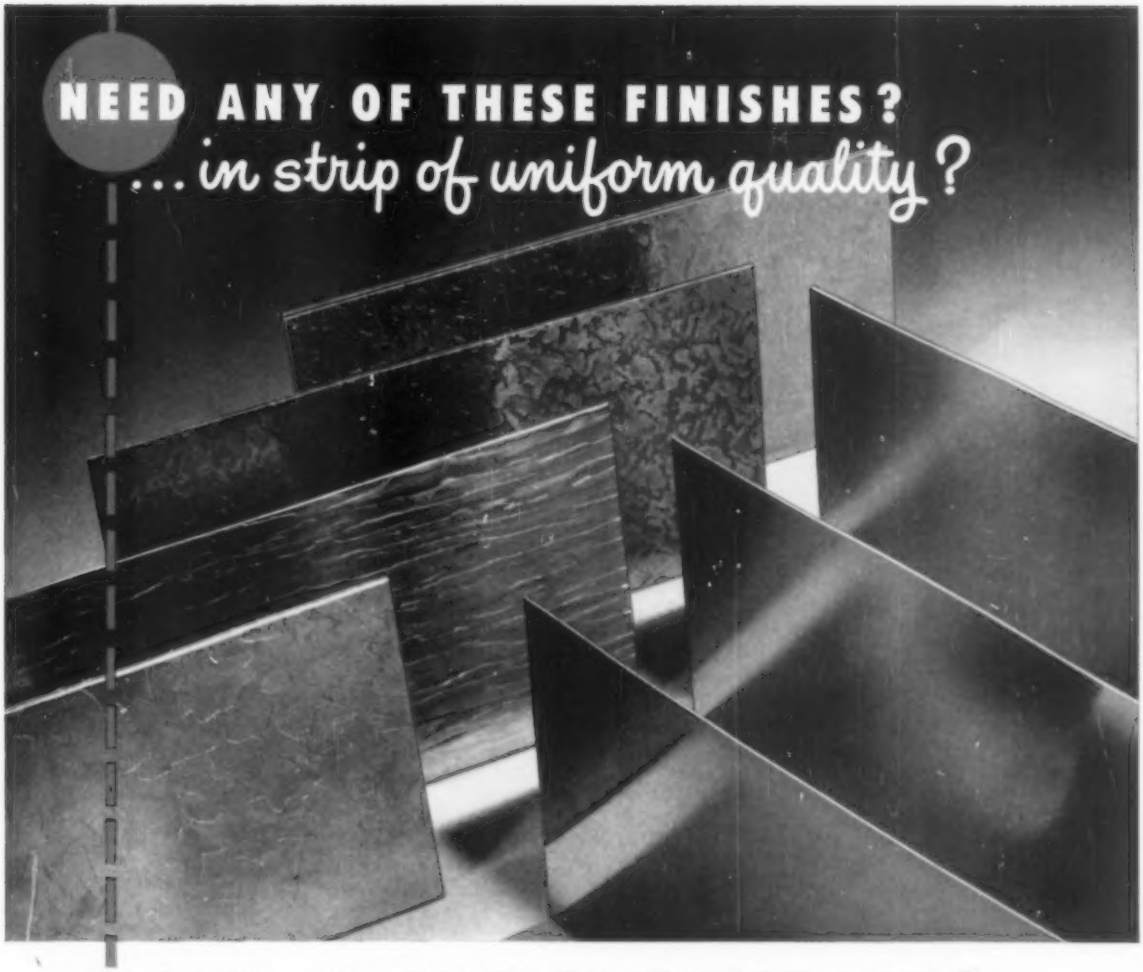
FILTERS FOR INTERNAL PIPING *(A and B above)* allow streamlined design plus the best infiltration. Flange mounting with external outlet *(C above)* and line-type *(large cutaway above left)* are just a few of many other possibilities.

CUNO

ENGINEERED FILTRATION

Removes More Sizes of Solids From More Kinds of Fluids

AUTO-KLEAN (edge-type) • MICRO-KLEAN (fibre cartridge) • FLO-KLEAN (wire-wound) • PORO-KLEAN (porous metal)



GET AMERSTRIP!

Why buy Amerstrip? Simply this: it brings you a finish tailored to your needs. High quality Amerstrip will minimize reject problems and improve the finished product. These are the best reasons, but not the only ones, for choosing Amerstrip cold rolled strip steel.

The metallurgical care that goes into making the Amerstrip, the even temper that goes with every shipment, also help you cut rejects and costs, help you make steadily improved products of steel.

Amerstrip comes in the widest available range of analyses, sizes, and finishes. You can get it embossed, coated, or in any of the standard finishes.

Specify Amerstrip.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION
GENERAL OFFICES: CLEVELAND, OHIO

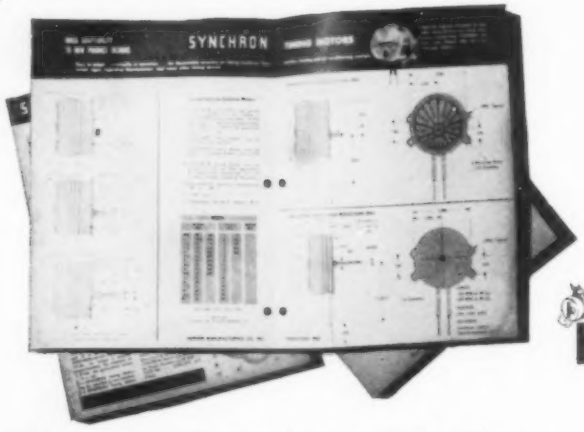
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

Amerstrip

USS

UNITED STATES STEEL

exploratory planning . . .



can often mean tremendous savings in production

SUCCESS OR FAILURE of your new product or timing device may well depend upon cost of production. It may be sound in principle and design . . . may meet a specific need . . . but if it costs too much to make, out the window it goes.

Often a slight change in motor application or gearing will enable you to trim manufacturing costs to a practical and profitable figure. It is here that Synchron engineers can help materially. Just tell us what is expected of our motors* . . . the general nature of the job the mechanism is to do, performance characteristics, and the proposed method of mounting. Send along a sketch if possible.

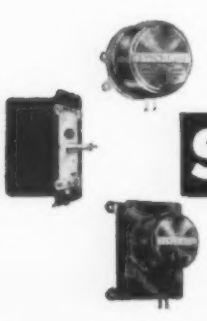
Our engineers will submit their suggestions and a sample motor . . . assistance which may save you many costly hours of research and testing. This service is strictly confidential, and available without obligation to established, rated organizations.

Get in touch with your SYNCHRON representative or write direct to the factory. You will receive prompt, efficient and courteous attention.

FACTORY REPRESENTATIVES:

Wesley & Fromm, 5254 W. Madison St., Chicago, Ill.
R. H. Winslow & Associates, 123 E. 37th St., New York, N. Y.
Electric Motor Engineering, Inc., 8255 Beverly Blvd., Los Angeles, Cal.
Cable-Hight Co., 1900 Euclid Ave., Cleveland 15, Ohio
Lawrence Sales Co., P. O. Box 13026, Dallas, Texas

*SYNCHRON synchronous motors operate smoothly and quietly in any position, at temperatures from —40° to +140° F. . . . start instantly under load . . . pull up to 20 in. oz. at 1 RPM. Available in 42 speeds from 0.8 RPM to 600 RPM.

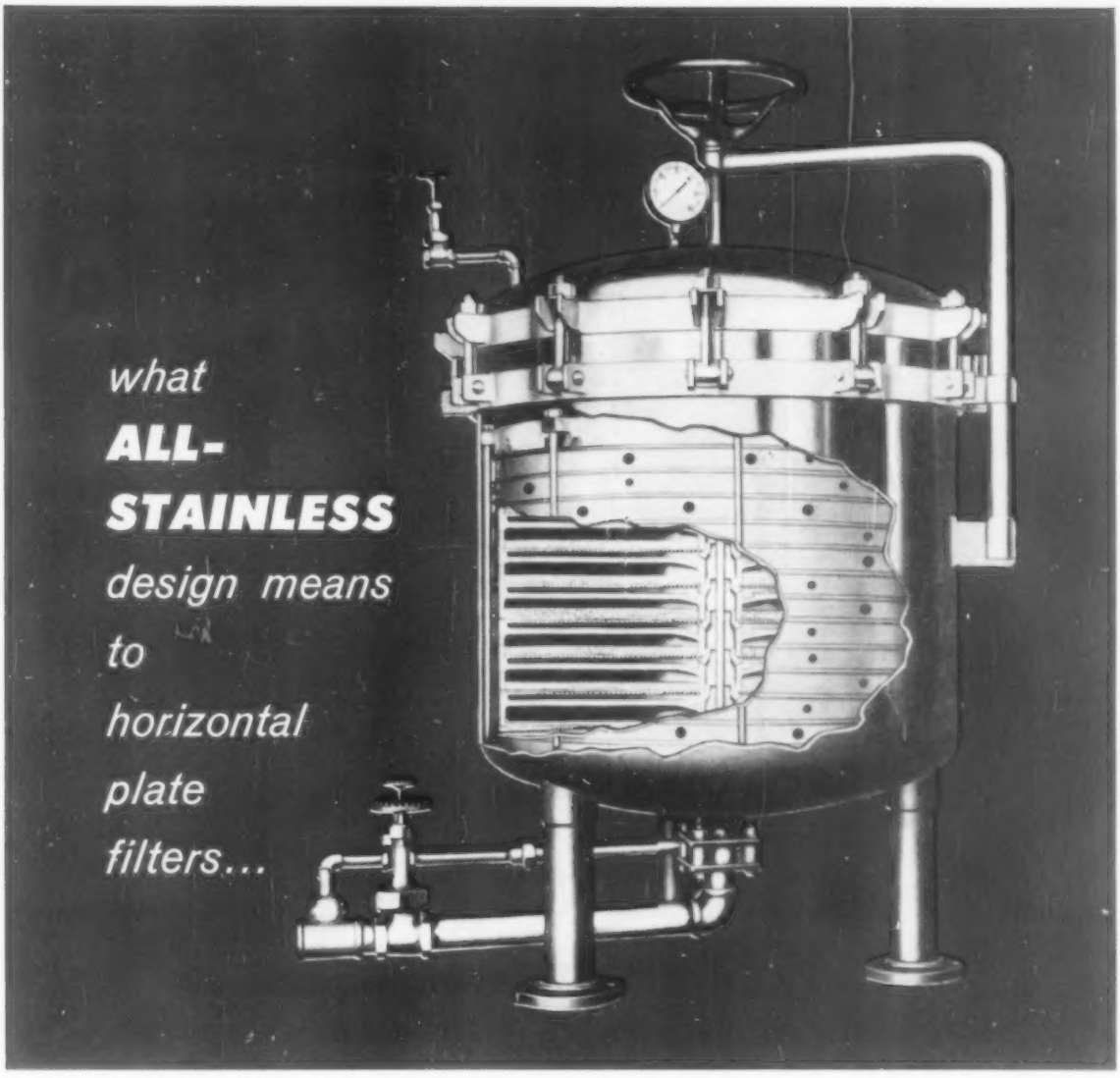


"Workhorse of the Industry"

SYNCHRON SYNCHRONOUS MOTORS, TIMING MACHINES, CLOCK MOVEMENTS, AND MAGNA-TORC D.C. MOTORS

HANSEN MANUFACTURING CO., INC. PRINCETON 5, INDIANA

Established 1907



Crucible stainless steel, type 304, is used throughout this Sparkler standard horizontal plate filter.

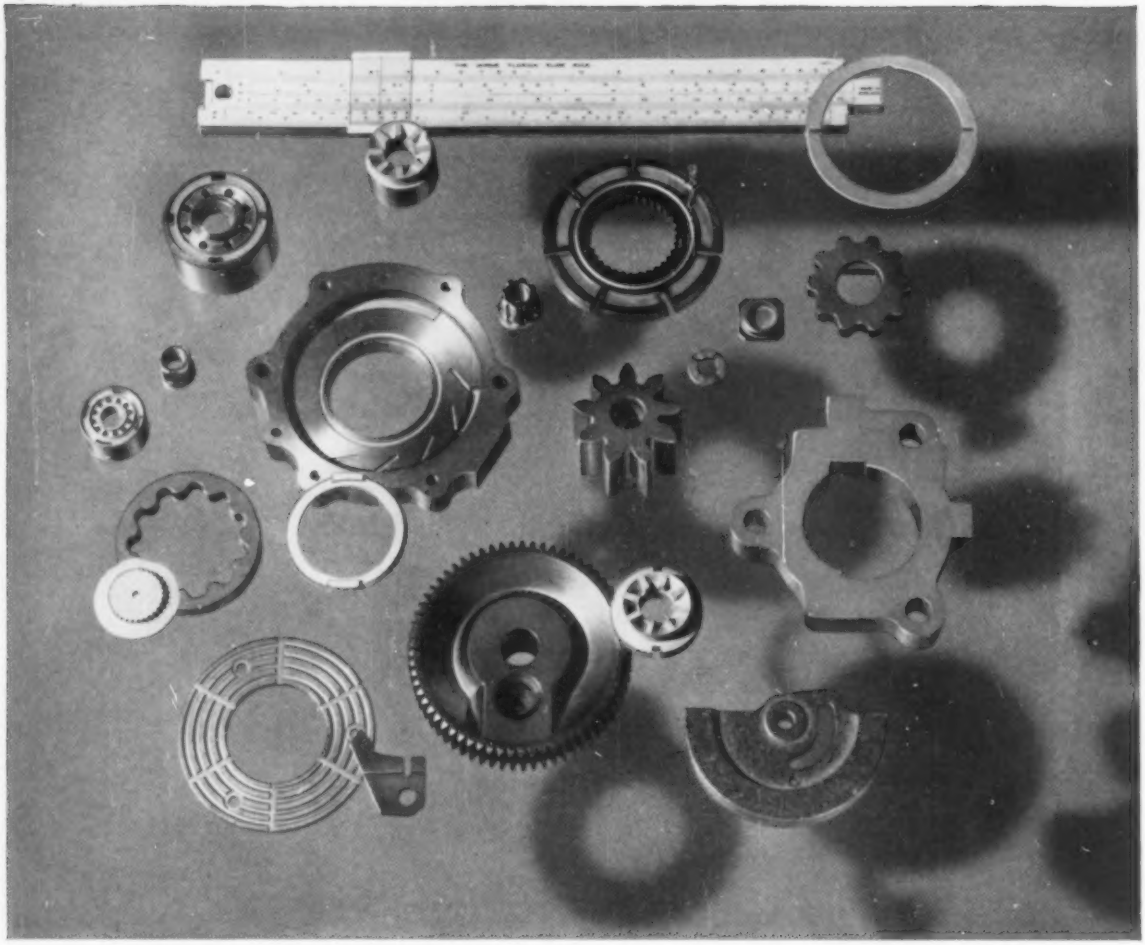
Constant filtration of chemicals, pharmaceuticals, foods and liquids subject this horizontal plate filter to pretty rugged corrosive, abrasive and temperature conditions. That's why Sparkler Manufacturing Co. uses all-stainless steel construction.

For stainless, first of all, fights off corrosive attack. And it's strong. Stainless becomes tougher the more it's used . . . which is another way of saying that, with stainless, abrasion is no problem. And neither is cleaning. For stainless steels' smooth, bright surface comes clean with a minimum of effort . . . stays clean longer.

The fact is, stainless makes any equipment stronger, longer-lasting, easier to use. Check with your local Crucible representative for help in selecting the best stainless grade for your job. Or write *Crucible Steel Company of America, The Oliver Bldg., Mellon Sq., Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America



A look at your needs . . . through the eyes of our experiences

You are looking at a typical group of precision parts each of which is being produced in large quantities by Moraine Products from metal powder. When you note the wide variation in shapes and sizes, you will realize each part was designed for a specific application.

What may not be obvious is the fact that, when Moraine Products is asked to produce parts like these, each part is carefully weighed in these terms: What will it be asked to do for the end product of which it will become a component?

Because we purchase or manufacture—for our own use, in our own plant—parts made by stamping, screw machine, forging, cold-heading, molding, and casting, we are familiar with a wide range of processes commonly used in industry. Consequently, our judgment can be considered realistic when we recommend metal powder and powder metallurgy as the material and the process best suited for a specific part.

Other Moraine products include: Moraine power brakes — Delco hydraulic brake fluids, brake assemblies, master cylinders, wheel cylinders and parts — Moraine friction materials — porous metal parts — rolled bronze and bi-metal bushings — self-lubricating bearings, and automotive engine bearings.

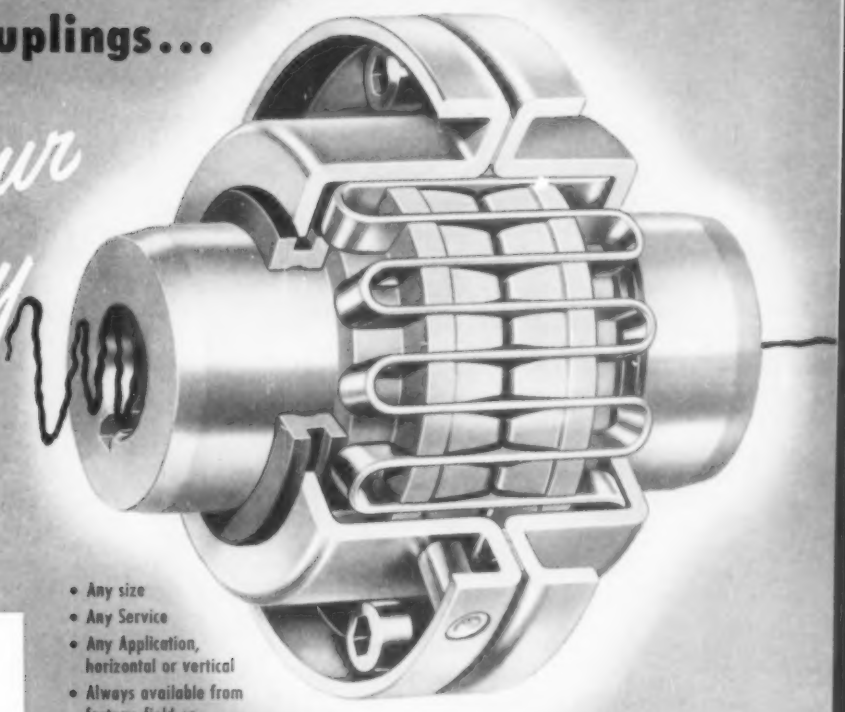
Another General Motors Value

Moraine Products

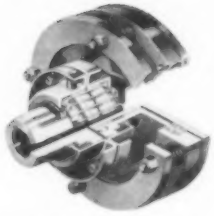
Division of General Motors, Dayton, Ohio

Falk Steelflex Couplings...

Protect your machinery in 2 ways



- Any size
- Any Service
- Any Application, horizontal or vertical
- Always available from factory, field or distributor stocks

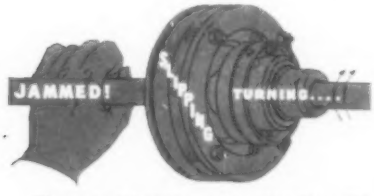


Falk Controlled Torque Couplings prevent damage from overloads

In applications where danger from overloads exists, use the FALK Type FT Controlled Torque Coupling. The Type FT has all the features and advantages of standard FALK Steelflex couplings—and, in addition, has an adjustable friction slip clutch, enabling the operator to set the coupling to slip at any predetermined overload.

This controlled-torque principle not only prevents transmission of dangerous shocks and limits overloads; it eliminates the breaking of shafts caused by jamming of driven equipment.

An outstanding advantage of the Type FT Coupling is that, as soon as the cause of the overload is removed, the entire coupling will rotate and transmit power without replacing parts or repairing coupling.



There's real economy in using Type FT Controlled Torque Couplings. Many users have reported that these couplings paid for themselves the very first time they slipped (under overload) because of the protection against damaged driving or driven machinery!

...cost less per year of service!

You get *double protection* when you connect your driving and driven machinery with a Falk Steelflex Coupling—the all-steel coupling with the exclusive grid-groove design! First, its *torsional resilience* smothers shock and vibration; and second, the Steelflex design prevents damage and lowered efficiency by accommodating shaft misalignment.

Why have increasing numbers of key men in industry standardized on Falk Steelflex Couplings? Their experience has proved that Falk Steelflex Couplings prolong the service life of their machinery... are trouble-free and need minimum maintenance... are easy to install, lubricate and disconnect... and *cost less per year of service* than ordinary couplings.

One basic Steelflex design—the type F, in its many sizes—is adaptable to more than 90% of all industrial applications. For applications involving danger from overloads, Modified Type FT Controlled Torque couplings (see column at left) are ideally suited. There are numerous other special or dual purpose Steelflex couplings for unusual applications. **Write to Department 247** for engineering bulletin, including selection and dimension tables.

THE FALK CORPORATION, MILWAUKEE, WISCONSIN

FALK

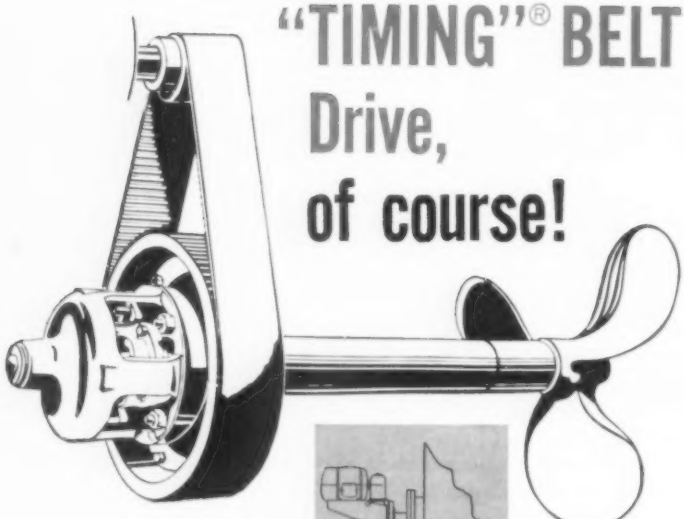
...a good name in industry

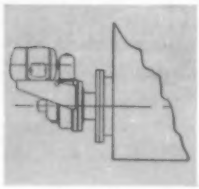
MANUFACTURERS OF:

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

What other single design improvement yields so many selling features?

adopting a Gilmer** "TIMING"® BELT Drive, of course!





Complete Mixer installed on side of tank.

*Jensen Engineering Company, Tulsa, Okla.

**The ORIGINAL Timing Belt.

A good example is the *JENSEN Model "BA" Shortstir Mixer**. Here is a simple 4-1 reduction drive from motor to propeller shaft... yet look at all the new selling features the adoption of a Gilmer "TIMING" BELT Drive provides the manufacturer! (The quotes below are taken verbatim from Jensen's *own literature.)*

"The JENSEN Shortstir Mixer, using the Timing Belt Drive, introduces a simple, rugged method of transmitting power from the motor to the propeller. It is much more compact, weight is greatly decreased, and elimination of couplings provides considerably less overhang from the motor.

"Motor alignment is set at the factory and a 'single bolt' adjustment for initial belt tension is the only adjustment required for the life of the belt.

"A Nylon facing and steel cable tensile members assure an almost unlimited belt life. Positive engagement of belt teeth with pulley grooves prevents slippage, power loss, and overloaded bearings common to most types of belt drives. Compactness greatly reduces vibration.

"No lubrication or belt dressing is required. Oil, however, does not harm the belt. All the advantages of a positive gear drive are accomplished plus the quietness and economy of a belt drive."

Stock or special Gilmer "TIMING" BELT Drives are obtainable through your local NYB&P Distributor. Many design engineers are now making profitable use of the 200-page "Timing" Belt Drive Engineering Handbook. If you are engaged in designing machinery and do not have a copy, write us on your company letterhead.

Gilmer V-BELTS AND "TIMING®" BELTS

NYB&P INDUSTRIAL RUBBER PRODUCTS

NYB&P — NEW YORK BELTING & PACKING CO. (Founded 1846) 1 Market St., Passaic, N. J.

America's Oldest Manufacturer of Industrial Rubber Products

NEW WEBSTER
Tandem Pump Combinations

CUT COSTS FOR POWER STEERING
and other Dual Applications

Webster Tandem Pump Combinations were developed especially to meet the demand for power steering on vehicles such as lift trucks, farm and construction equipment. They provide opportunities for substantial savings in all applications where two separate hydraulic power circuits are to be served.

Webster's Tandem Pump Combinations can be furnished in a wide range of capacities. For example, for 1750 rpm installations, capacities of the larger pump in the combination can range from 4.8 to 29.0 gpm at 1000 PSI. The smaller pumps, normally used on power steering applications, have a capacity range from 1.0 to 4.0 gpm at 1000 PSI.

This new Webster development reduces installation and equipment costs in many ways.

For example:

Only one driving medium • Shafts of the two pumps are mated to operate from a common driving medium, thus eliminating the cost of a second drive unit.

Less hydraulic piping • The two pumps have a common inlet, thus reducing the amount of hydraulic piping required.

Adaptable • If only the large pump is required initially, this can be supplied with a cover plate, which enables later addition of the smaller pump without additional inlet piping.

Compact design • Eliminates many installation problems and reduces installation time. Overall lengths of typical combinations range from 8 3/32" to 10 1/8".

The unique design of Webster pumps provides greater flexibility—enables us to adapt standard units to solve most special problems—thus making substantial savings for you. And you get the quality construction and advanced engineering characteristic of Webster's complete line.

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

RACINE • WISCONSIN

Write today for complete information

☐ Please send us complete information on new Webster Tandem Pump Combinations

☐ Please send catalog on complete Webster line

Name_____

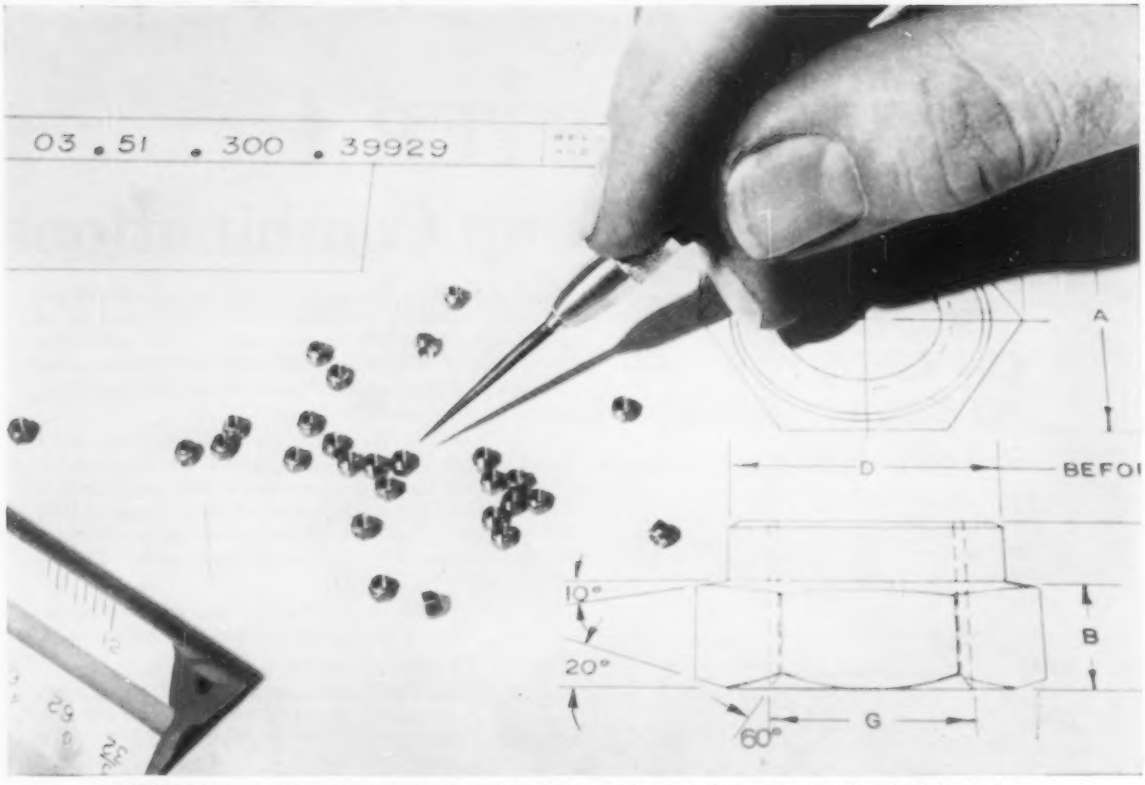
Title_____

Company_____

Street_____

City, Zone & State_____

MANUFACTURERS OF A COMPLETE LINE OF OIL HYDRAULIC PUMPS FROM 1/5 TO 30 GPM CAPACITY



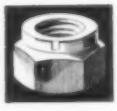
FLEXLOC Micro locknuts meet designers' needs for tiny precision nuts that retain strength and holding power in the smallest assemblies—servomechanisms, electronic and electrical equipment, all miniature devices.

Design Lighter, More Compact Products with New FLEXLOC Micro Nuts

Standard Miniature Locknuts Permit Design Engineers to Develop and Fasten Smaller Assemblies Safely

SIZE	Across Flats		Shoulder Height		Across Corners	Height +.000 −.003
	MAX.	MIN.	MAX.	MIN.	MIN.	
0-80 NF-3B	.111	.107	.047	.042	.123	.075
1-64 NC-3B	.127	.123	.0635	.0585	.141	.090
1-72 NF-3B	.127	.123	.0635	.0585	.141	.090
2-56 NC-3B	.158	.153	.068	.063	.176	.105
2-64 NF-3B	.158	.153	.068	.063	.176	.105
3-48 NC-3B	.190	.183	.071	.066	.210	.120
3-56 NF-3B	.190	.183	.071	.066	.210	.120
4-40 NC-3B	.190	.183	.072	.067	.210	.120
4-48 NF-3B	.190	.183	.072	.067	.210	.120

STANDARD FLEXLOC Micros—in sizes ranging from 0-80 to 4-48—are available in brass (either plain or cadmium plated). Consult SPS for miniature nuts of other conventional materials.



New FLEXLOC Micro locknuts are smaller and lighter than regular FLEXLOCS of the same nominal diameter. Wrenches of smaller size are used to install them. Mating joints or flanges can be designed smaller—with no loss in strength or convenience of assembly.

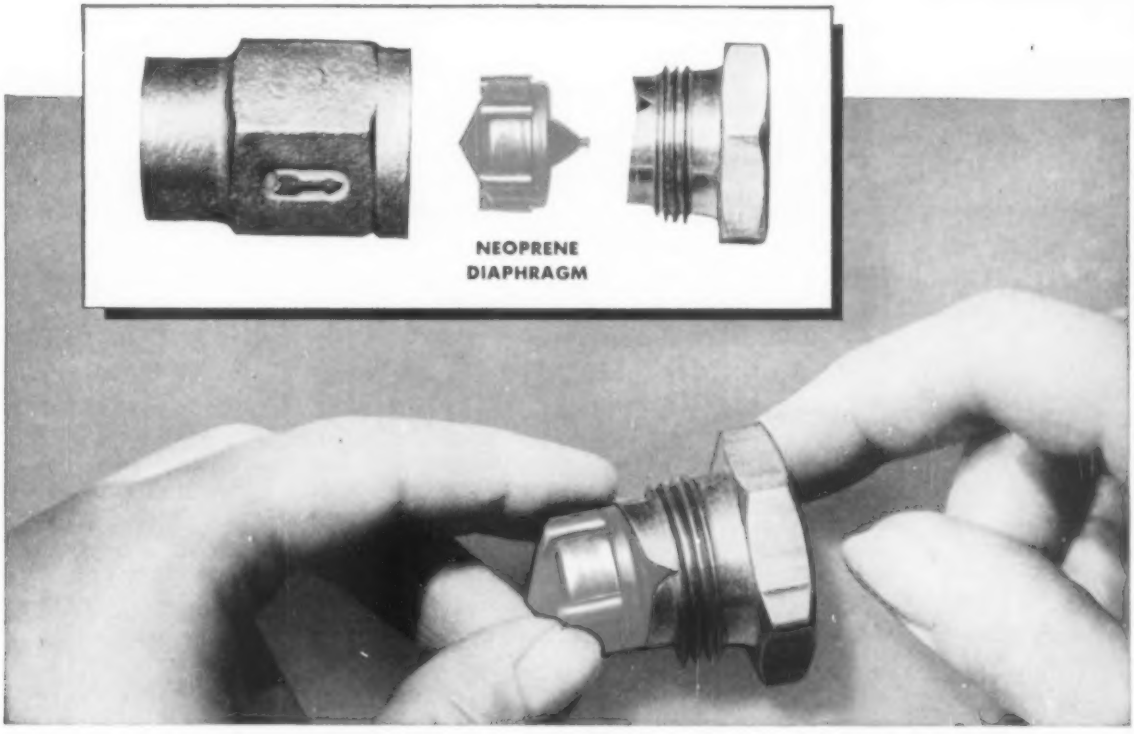
FLEXLOC Micros have all the advantages of larger FLEXLOCS. One-piece, all-metal construction—nothing to put together, come apart, lose or forget. Use them as lock or stop nuts—they stay put anywhere on a threaded member as soon as the locking threads are fully engaged. Uniform locking torques insure accurate preloading. There are no nonmetallic inserts to pop out or deteriorate. Moisture, dryness, oil, temperatures to 250°F won't affect these Micro nuts. Just screw them on. They lock and stay locked. Vibration won't shake them loose.

For complete information on FLEXLOC Micro locknuts, consult your authorized SPS distributor. Or write STANDARD PRESSED STEEL CO., Jenkintown 28, Pa

STANDARD PRESSED STEEL CO.

FLEXLOC® LOCKNUT DIVISION SPS

JENKINTOWN PENNSYLVANIA



Valve diaphragm of DU PONT NEOPRENE

resists water absorption . . . stays flexible, resilient

This improved flow control valve assures a constant rate of water flow despite fluctuating inlet pressures. A neoprene diaphragm, specially compounded for low water absorption and a very stable modulus of elasticity, provides the controlling element in this device.

Designed for drinking fountains, washing machines, dishwashers, and other applications where constant rate of flow is a problem, the valve is simple and effective. Note the broad shallow V cut in the orifice (as well as the more obvious little notch). As inlet pressure increases, the neoprene diaphragm flexes into the broad V of the orifice, reducing the opening and throttling the flow. When pressure decreases, the diaphragm relaxes; the opening is enlarged; and the flow rate remains constant.

The valve is designed to maintain constant rate of flow (within ± 10%) at inlet pressures between 10 and 150 psi. in the temperature range between 50 and 150°F. The valve can be counted on to give dependable service indefinitely—thanks to neoprene, Du Pont's chemical rubber.

Next time your design calls for a resilient material, try neoprene. It has solved countless problems for designers over the years, and you'll find its reputation for trouble-free performance is well deserved.

Remember, of all resilient materials, only neoprene has balanced resistance to:

- Oils, solvents, most chemicals
- Permanent distortion
- Air and gas diffusion
- Abrasion, cutting, chipping
- Low-temperature stiffening
- Sunlight and weathering
- Oxidation
- Heat

NEOPRENE

The rubber made by Du Pont since 1932

DUPONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

READ "THE LANGUAGE OF RUBBER"—A series of technical articles now appearing in each issue of the free NEOPRENE NOTEBOOK. Mail this coupon . . . add your name to the mailing list today!

E. I. du Pont de Nemours & Co. (Inc.),
Elastomers Division PE-1,
Wilmington 98, Delaware.

*Name*_____ *Position*_____

*Firm*_____

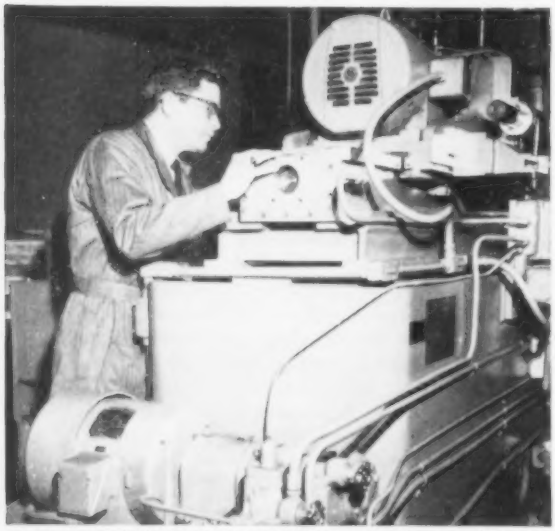
*Address*_____

*City*_____ *State*_____

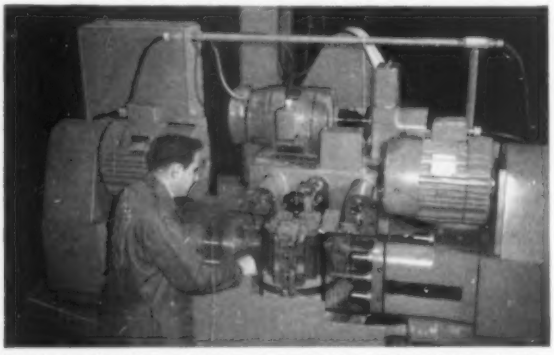
Designer's

New machines with TRI CLAD motors highlight "motor switchover" at Machine Tool Show

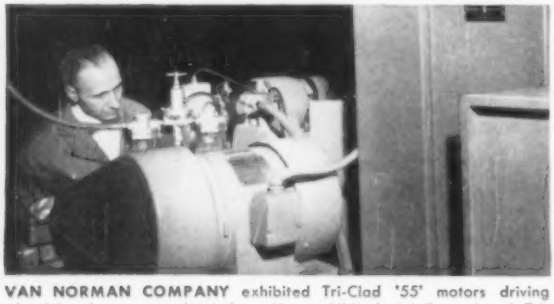
The giant Machine Tool Show at Chicago demonstrated the tremendous effect made by the electric motor re-rating program announced in 1953. Over 62% of the G-E motors between 1 and 30 horsepower installed on machines at the show are built to the new dimensions. One reason for this big "motor switchover" by designers of machine tools is the new and better Tri-Clad '55', G.E.'s completely redesigned line of more powerful, more compact motors. Weight is reduced up to 33% in some ratings, size cut up to 40%. Installed on the newest machine tools, Tri-Clad motors give a neat, compact, modern appearance. Available in a wide range of ratings and enclosures, they're easily installed and maintained, and shipping and handling costs of your product are reduced. Check Bulletin GEA-6200.



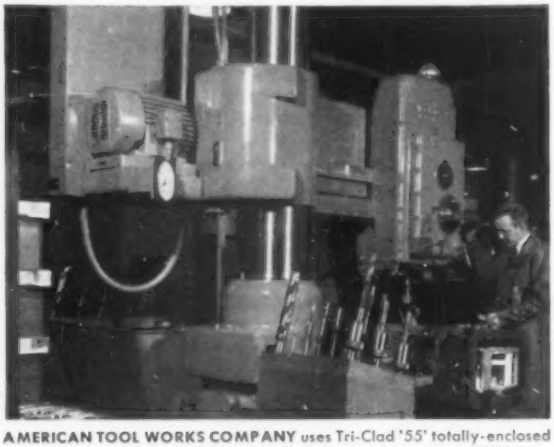
MORRIS MACHINE TOOL COMPANY'S center column machine, displayed at the Machine Tool Show in Chicago, uses several Tri-Clad '55' motors. Note attractive appearance of motors on this modern machine.



GOSS & DELEEUW exhibited multiple spindle tool rotating chucking machines. Tri-Clad '55' totally-enclosed fan-cooled motors in the 1–15-hp range are used for the tapping, drilling and feed drives.



VAN NORMAN COMPANY exhibited Tri-Clad '55' motors driving wheel heads on several grinders. Also exhibited: totally-enclosed Tri-Clad '55' motors for feed and spindle drives on milling machines.



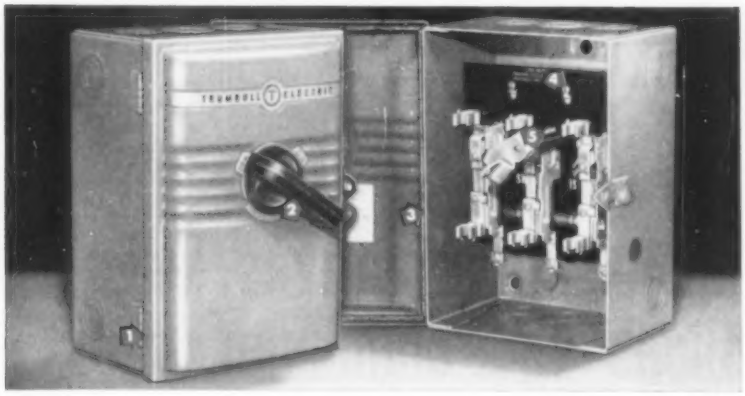
AMERICAN TOOL WORKS COMPANY uses Tri-Clad '55' totally-enclosed fan-cooled motor on its 32 speed Hole Wizard radial drill. TEFC construction assures smooth performance despite adverse atmospheres.

GENERAL ELECTRIC

Digest

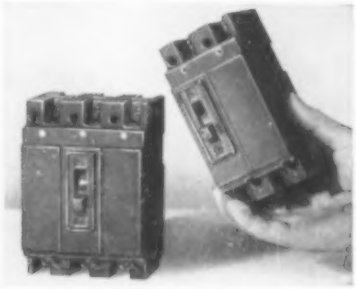
MOTOR & CONTROL HIGHLIGHTS

Tests prove G-E heavy-duty HCI switch provides extra safety margin of 66%



Normal tests call for a switch to operate at 6 times the motor full-load current. General Electric's 30-amp heavy-duty HCI switches operate successfully at 10 times full-load current, an extra safety margin of 66%. In addition, pole units can be individually replaced, reducing maintenance costs, and straight-in wiring makes installation simple. Quick-make, quick-break action helps prevent burning: operator can't "tease" contacts in or out. Sturdily constructed, these switches withstand severe electrical and mechanical stresses in a wide range of machine-tool control uses. Available in 30 to 200 amps, 125 to 600 VAC and 240 VDC in two- or three-pole construction.

Note these features above: 1. Rigid piano-hinges on heavy steel door withstand abuse. 2. Easy-grip, unbreakable, front-operated handle. 3. Standard rubber gasket makes box semidust-tight. 4. Line shield guards against accidental contact. 5. Door interlocked. When handle is padlocked, door cannot be opened.

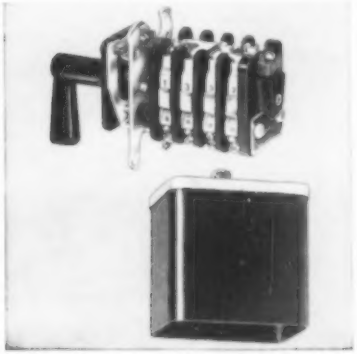


Specify G-E circuit breakers for fast action, durability

General Electric molded-case circuit breakers must meet 16 tests for quality, and are U/L listed. De-ionizing arc-quencher keeps operation cool and lengthens life. Both thermal and magnetic trip give safer positive protection, and fast indication of "off," "on," or "tripped," means production is not delayed. Solderless lugs and straight-in wiring make installation speedy, easy. Units are available with all standard accessories for industrial uses, and with enclosures for every purpose, including lead-plated water- and dust-tight enclosures for corrosive atmospheres. Separate stocking of breakers and enclosures speeds delivery. Bulletin GEC-1031.

Highly-versatile control switch: 50,000 circuit combinations

General Electric's SB-1 control switch has been used for as many as 50,000 different circuit combinations—from a meter to a complicated locking mechanism for a giant bridge. Continuous rating is 600 volts, 20 amperes. Interrupting rating depends on circuit voltage. Single switches having 16 stages (32 contacts) are commonly furnished. GEA-4746A gives complete details.



General Electric Co., Apparatus Sales Division, Sec. C668-126, Schenectady, N. Y.
Please send me the following bulletins:

√ for reference × for immediate project

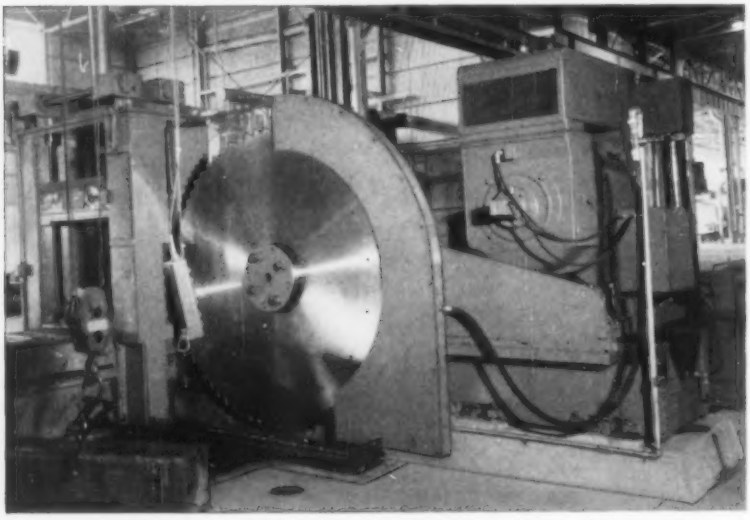
- ☐ GEA-6200 Tri-Clad '55' Motors
- ☐ GEC-1031 G-E Circuit Breakers
- ☐ GEA-4746A SB-1 Control Switch

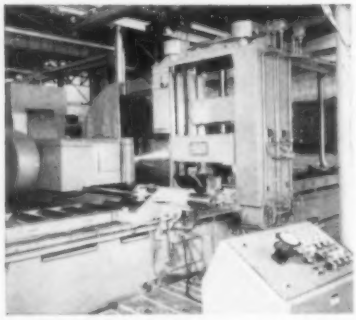
CONSULT YOUR SWEET'S PRODUCT DESIGN FILE. You'll find everything electric for machinery manufacturers in the General Electric Section.

NAME ..... COMPANY .....

CITY ..... STATE .....

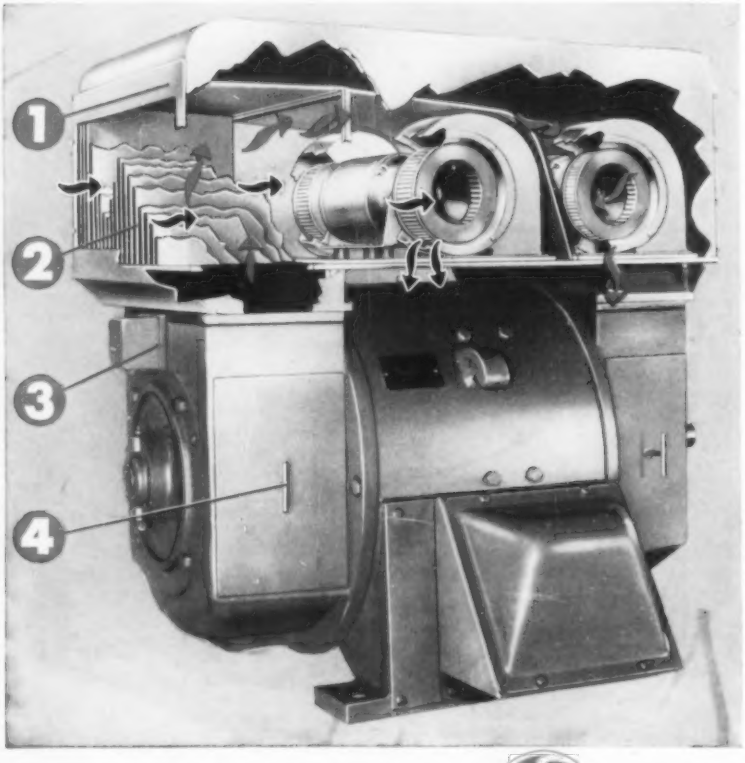
TURN PAGE FOR MORE G-E PRODUCT HIGHLIGHTS





G.E. ENGINEERED the application of a totally-enclosed unit-cooled d-c motor as a drive for this giant saw. Above, motor is at back left, mounted with saw on movable bed. At left, saw blade is in front, with motor's vent opening in view at top right. Motor is capable of handling blades even larger than the blade shown.

G-E d-c unit-cooled motor drives large circular saw, slices 43″ aluminum ingots



At Alcoa-operated U.S. Air Force plant 47, General Electric's unit-cooled d-c motor helps perform a gigantic operation. Motch and Merryweather's high speed circular saw, largest they have built, is driven by the 150-hp G-E motor, with power supplied by a G-E Speed Variator. Its 84-in. saw blade can cut aluminum forging ingots up to 43 in., and the saw-blade speed is variable from 400 to 3200 surface feet per minute. Because of the fine mist created by the blade in cutting aluminum, the G-E d-c unit-cooled motor was selected to help prevent foreign material from entering and harming the motor.

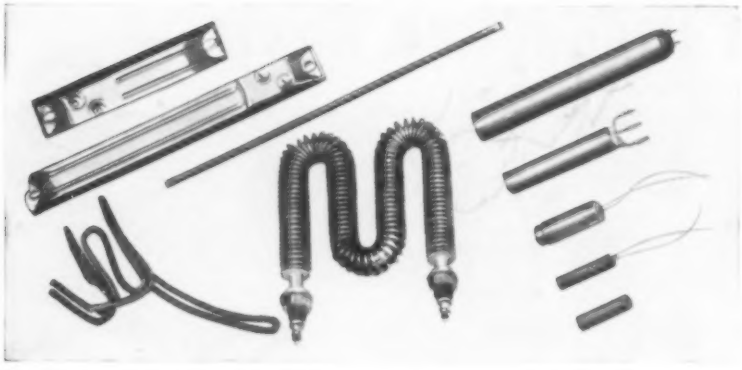
Compact, easy to maintain, no filters to clean, dependable G-E unit-cooled motors are available at all rated speeds. Where water or moisture, metal particles, dust, dirt, oily vapors, fly ash, or other harmful materials are present, this better-protected motor will effect real operating economies.

At left, four big features are shown:
1. Compact, top-mounted cooling unit falls within length and width of main motor.
2. Smooth vertical plates are self-cleaning.
3. Protective thermostat helps safeguard main motor in case of blower-motor power failure.
4. Easy access to inspection opening—no tools required. Red arrows indicate ventilation arrangement. Bulletin GEA-6091A gives complete details.

GENERAL ELECTRIC

Designer's Digest

PRODUCT HIGHLIGHTS



Build in heat with G-E Calrod* heaters in hundreds of types, shapes, sizes, ratings

To help speed your customers' processes and help them reduce costs, a wide variety of General Electric Calrod heaters offer almost unlimited applications in heating surfaces, liquids, and process air and melting metals. Types, illustrated above, include cartridge, fin, strip and tubular. Made from high-quality metals, magnesium oxide, and the finest conductors available, Calrod heaters give long life, dependable service. Today, Calrods are easier to install, more compact, and, depending on the size or shape of your product, you can wrap-around, cast-in, clamp-on or insert Calrod heaters to give you the most efficient method of heat transfer. You may select standard heaters or have them built to your requirements. The heating specialist in your nearby G-E Apparatus Sales Office will help you modernize existing designs or develop new processes. Call him early in your planning for application assistance. Bulletins GEA-5866 and GEC-1005F.

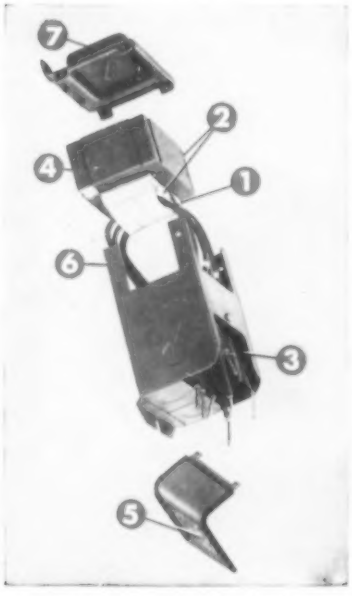
*Registered Trade-mark of General Electric Company

New G-E control transformers: smaller, lighter, more dependable

Featuring 50-, 60-cycle, series multiple operation, these new transformers offer size and weight advantages not only over the previous line but over nine competitive makes. Saves on shipping costs and end-product size. Check these outstanding features.

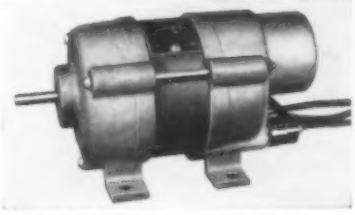
1. Coil layer-wound with new Class B Alkanex* treated wire. 2. Core and coil pressure-vacuum impregnated for greater dielectric strength. 3. Roomy wiring compartment in 25–2000 va ratings. Available with open wiring in ratings 25–250 va. 4. Unique core design eliminates corner bolts; reduces stray flux and core losses. 5. Wiring diagram printed on cover of wiring compartment. 6. One-piece welded "four-poster" case affords maximum protection for lamination corners. 7. One-piece pressed-steel cap securely locks rigid "four-poster" case design. Bulletin GED-2767.

*Reg. Trade-mark of General Electric Co.



G-E selsyns automatically synchronize remote signals or controls

Two or more remote points of a system can be electrically interconnected with General Electric selsyns to provide synchronized control or signals between them, automatically. Compared with ordinary control systems, the time required to transmit readings or actions is greatly reduced. These versatile selsyns can be set up to give accurate indication at several points, and because of their careful design they maintain their accuracy indefinitely. Economical in operation, they require little or no maintenance and do not require specially trained operators. Use them as components for indicating positions of water level, governors, turntables, valves, elevators; for control of material handling, dynamic balancing; for room-to-room and distribution-system signals; and for an extremely wide variety of other devices and systems. **For details see GEA-2176C.**



General Electric Co., Apparatus Sales Division, Sec. C668-127, Schenectady 5, N. Y.

Please send me the following bulletins: × for reference √ for immediate project

- ☐ GEA-6091A Unit-cooled d-c Motors
- ☐ GED-2767 New Control Transformers
- ☐ GEA-2176C Selsyns
- ☐ GEA-5866 Calrod Heaters for Machinery Manufacturers
- ☐ GEC-1005F Calrod Electric Heaters and Heating Devices

CONSULT YOUR SWEET'S PRODUCT DESIGN FILE. You'll find everything electric for machinery manufacturers in the General Electric Section.

NAME ..... COMPANY .....

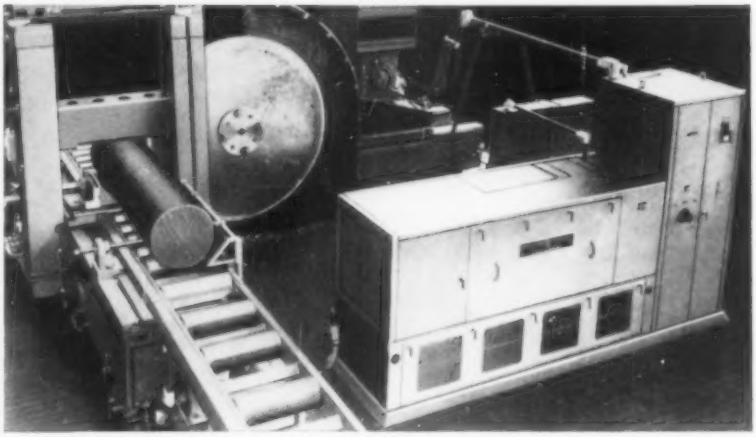
CITY ..... STATE .....

G-E Packaged Speed Variator Lowers Production Costs

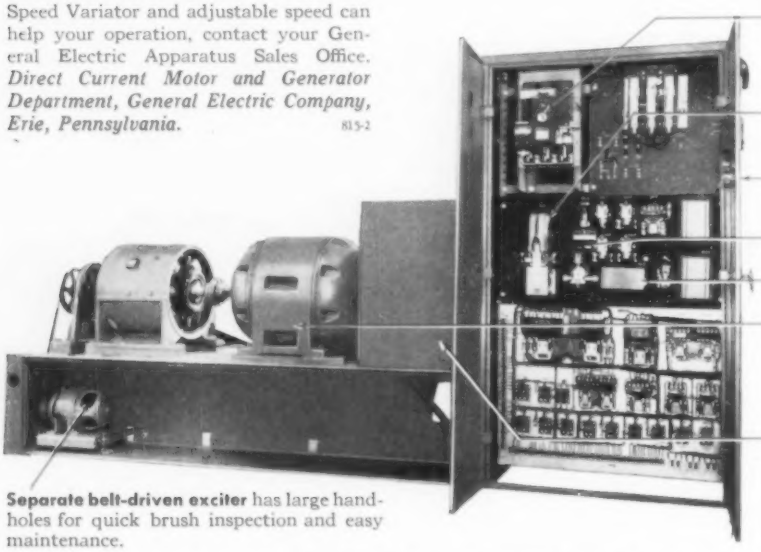
REDUCED PRODUCTION COST per unit machined is provided by the G-E Speed Variator, a packaged adjustable-speed d-c drive operating from a-c power. Supplying constant surface-cutting speeds, quick acceleration, deceleration and reversals, the Speed Variator assures better quality control, increased production and longer tool life. When combined with tracer control, it provides the wide versatility required for automatic processes.

FOR EASY, LOW-COST INSTALLATION, the Speed Variator comes to you completely tested and packaged for your application. Power unit requires no special foundation and may be placed in any convenient location. After simple connections are made between the Speed Variator, operator's control and motor, the drive is ready for operation.

FOR COMPLETE DETAILS on how the Speed Variator and adjustable speed can help your operation, contact your General Electric Apparatus Sales Office. *Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.* 815-2



ACCURATE SPEED CONTROL provided by G-E Speed Variator helps boost output, reduce costs when powering high-speed saws *(above)*, lathes, boring mills and many other machine tools.



Separate belt-driven exciter has large handholes for quick brush inspection and easy maintenance.

Electrically operated air circuit breaker provides better protection for a-c motor of m-g set.

Standard, stocked control components utilized throughout for quick maintenance.

Strong, rigid steel cabinet is pressurized to help keep dirt and dust from controls and m-g set.

All devices identified for quick, easy recognition.

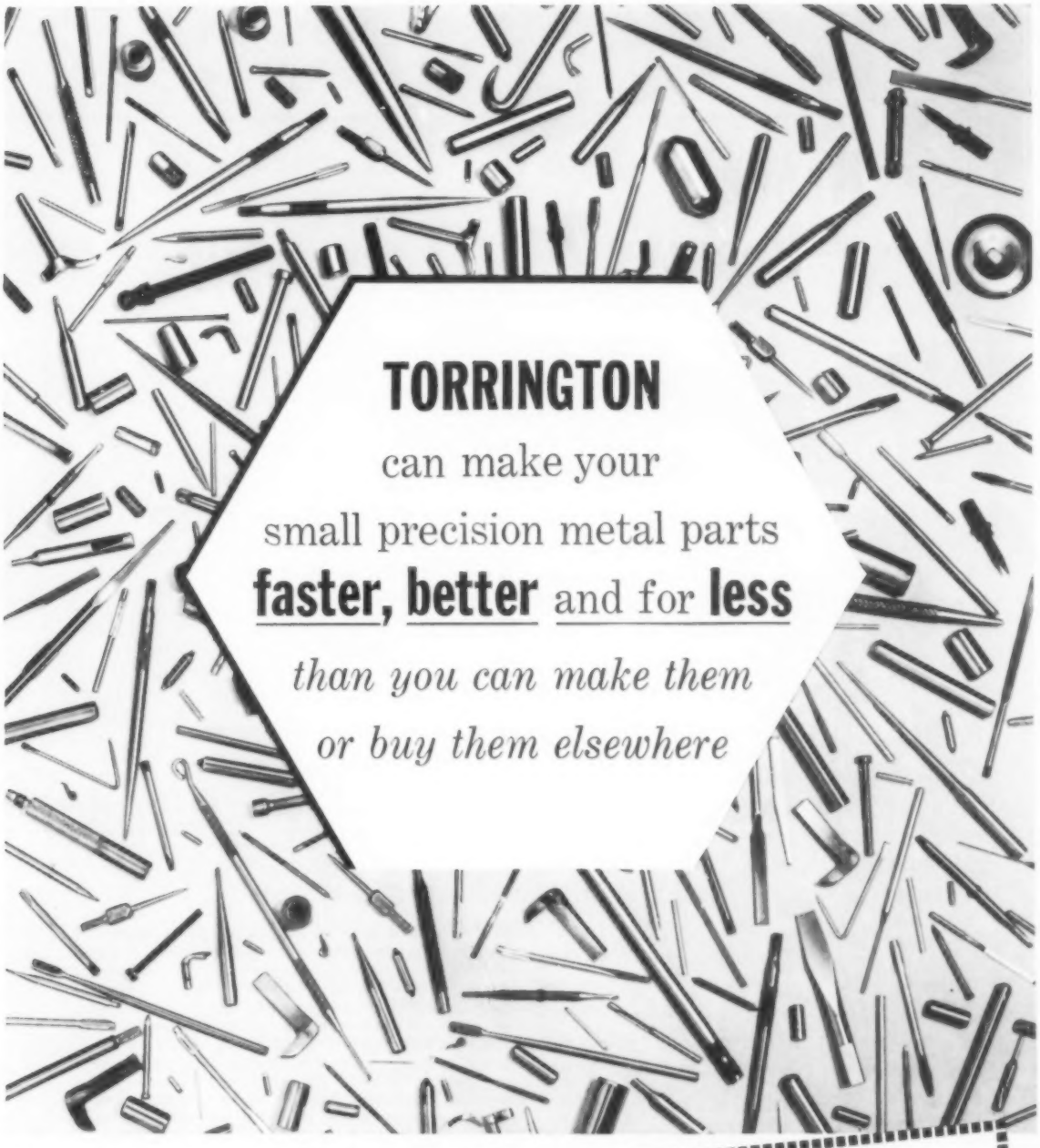
D-c overload protection.

Motor-generator set is of strong construction and alignment is precise. When installed, m-g set is better protected in steel cabinet.

Large fan within enclosure forces filtered air over m-g set and controls for proper cooling.

"E" SIZE SPEED VARIATOR SHOWN WITH M-G SET ENCLOSURE REMOVED.

GENERAL ELECTRIC



These are typical of parts that Torrington produces daily by the hundreds or millions. If you use similar small precision parts, mail the coupon today for the Torrington Small Precision Parts condensed catalog. Even better, send a sketch, blueprint or sample part. We will give you a prompt quotation which will mean substantial savings to you.

THE TORRINGTON COMPANY
Specialties Division
230 Field Street, Torrington, Conn.

TORRINGTON SPECIAL METAL PARTS

Makers of Torrington Needle Bearings

THE TORRINGTON COMPANY
Specialties Division
230 Field Street, Torrington, Conn.

☐ **Please send the Torrington Small Precision Parts condensed catalog**

☐ **Please have a salesman call**

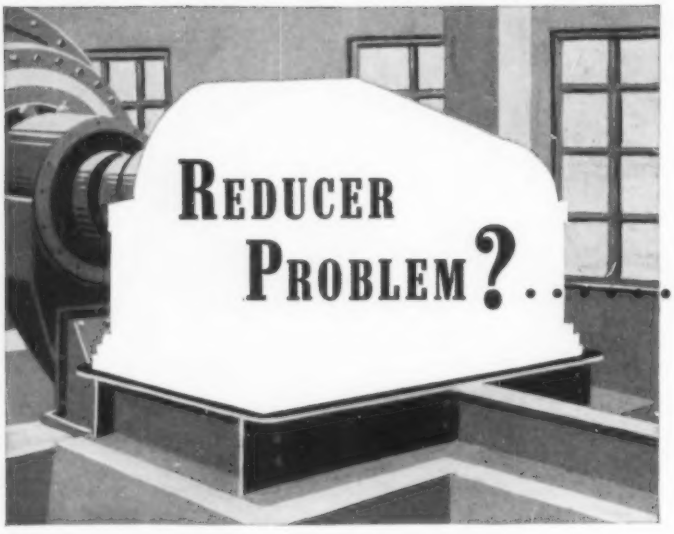
Name_____

Title_____

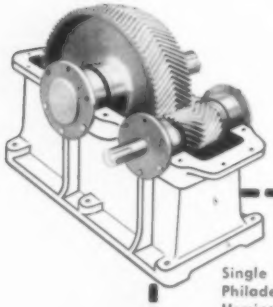
Company_____

Address_____

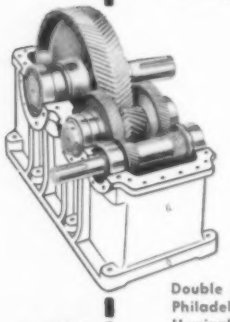
City_____ Zone____ State_____



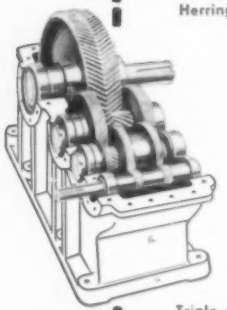
REDUCER PROBLEM?.....consult



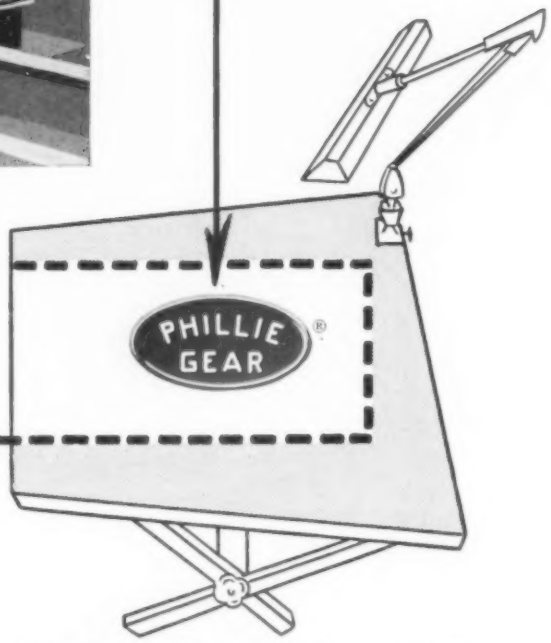
Single reduction
Philadelphia
Herringbone Reducer



Double reduction
Philadelphia
Herringbone Reducer



Triple reduction
Philadelphia
Herringbone Reducer



If you have a problem involving high horsepower speed reduction with heavy shock loads, Philadelphia Herringbone Reducers are the answer. These quality-built units are available in Single, Double and Triple Reduction types, offering a wide selection of capacities and reduction ratios. The continuous tooth type herringbone gears assure evenly distributed pressure over each tooth from the top to the working depth line, — which means exceptionally long life, minimum vibration, quiet operation and maximum transmission of power . . . Thousands of Philadelphia Herringbone Reducers are in daily use, in most every line of industry. Be convinced, send for Catalog H-49.

PHILADELPHIA GEAR WORKS
INCORPORATED
ERIE AVE. AND G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.,
BALTIMORE • CLEVELAND
Virginia Gear & Machine Corp., Lynchburg, Va.
Industrial Gears & Speed Reducers • LimiTorque Valve Controls
Established 1892

Perspectives

IN DESIGN AND DEVELOPMENT

ROCKETS BECOME POPULAR

A discussion on rockets or rocket ships invariably will draw a large crowd. For example, while the ASME was holding its Diamond Pubilee Annual Meeting in Chicago last November, the American Rocket Society was holding its 25th Anniversary Annual Meeting at the same time in the same city. While all the meetings were well attended, one of the most popular was the Space Flight Symposium. With eight panel members, all well known in the field of rocket design, the topic of discussion naturally was the earth satellite program, its problems, and what has been accomplished to date—that is, all unclassified information. The phase handled by the Defense Department—the launching rockets, the firing and observation sites, and all aspects of the launchings—is classified, perhaps because of its connection with the intercontinental ballistic missile program.

The proposal for an earth satellite vechicle (ESV) was made some time ago. At the end of 1948, the then Secretary of Defense, James V. Forrestal, announced that such study already was going on. Original planning for the International Geophysical Year (IGY) in 1950 also urged the use of ESV's for scientific research.

SATELLITE ONE PART OF LARGE PROGRAM

The upper atmosphere rocket and satellite studies (official title), is just one of twelve parts of the U. S. program in the (IGY), which starts in July of 1957 and continues to the end of 1958. Other items on the program: aurora and airglow; cosmic rays; geomagnetism; glaciology; ionosphere; longitude and latitude; meterology; oceanography; seismology and gravity; and solar activity.

This international cooperative effort of gathering scientific data is not new. The first polar year was held in 1882 and 1883, when meterological, magnetic and auroral stations were first set up in Arctic regions. In the second international polar year 1932-1933, ionospheric observations were included. One of the reasons the IGY is being held in 1957-58 is that a period of maximum solar activity will exist at this time. The program will be greatly expanded, with different projects scattered throughout the world. The two previous international polar years were for the most part limited to the North Pole regions.

SATELLITE ROCKET ENGINE NOT NEW

Not generally realized is that the rocket engines which will push the satellite up to its highest point are not of some new design. What is new is that the rocket is of three-stage design, but will be using engines similar to those used in guided missiles like General Electric's Hermes missile, Glenn L. Martin's Viking, and others. The real problem is in the timing and releasing of the different stages, particularly the last stage which must send the satellite on its course. It has been computed that a difference in velocity of 100 ft/sec will result in a difference in height from

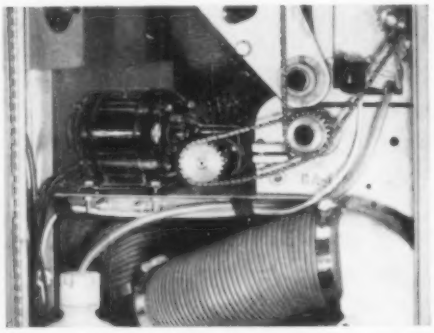
(Continued on page 131)

Why Bodine Motors were selected for Peck & Harvey Whiteprinters

1 This is a P&H Whiteprinter. It prints and develops black line and colored line whiteprint reproductions...

2 ...reproductions of memos, forms, letters, documents, plans, diagrams, sketches, charts, reports ...and what have you.

3 You merely slip whatever you want to copy into the Whiteprinter...just like our blonde friend does...a few seconds later out comes your copy.



4 The printer and developer mechanism of P&H Whiteprinters are powered by a Bodine Type NSH-33R. 1/20 H. P. motor.

5 This gentleman is Mr. Arthur Harvey, President, Peck & Harvey Manufacturing Corp., builders of P&H Whiteprinters.

Your firm has given us valuable engineering assistance and cooperation. We are particularly happy with the "know-how" at Bodine for the very special motors we require. Bodine motors are of excellent quality, reflecting the finest workmanship and care in manufacture.

6 Mr. Harvey has some rather nice things to say about Bodine Fractional Horsepower Motors... see above.

BODINE

50th Anniversary

BODINE

fractional horsepower

MOTORS

7 Be sure your motor is as good as your product. For information contact Bodine Electric Co., 2260 W. Ohio St., Chicago, Ill.

BODINE MANUFACTURES FRACTIONAL HORSEPOWER ELECTRIC MOTORS FOR:

adding machines
letter openers
sanders
vending machines
exhaust fans
duplicating machines
portable tools
sound recorders
air conditioners
check protectors
respirators
voltage regulators
x-ray timers
traffic signal timers
stirrers
calculating machines
envelope sealers
diesel governors

. . . and for many other applications.

Ask for a sample copy of "The Motorgram," a bi-monthly publication discussing application and design of fractional horsepower electric motors.

the earth of ±60 miles. Also, an angular error of one degree will produce an error of 65 miles in the satellite's orbit.

The orbit will be elliptical—about 250 miles away at its closest point, and maybe 800 at its greatest—but will approach a circular one before dropping to earth. If the satellite drops too far into the atmosphere, its lifetime will be reduced due to drag. There are two ways to set the satellite on its course, and as yet no decision has been made as to which one will be used. One method is to consume two stages of the rocket going straight up to the orbital height, with the third stage firing at right angle to the line of ascent. This last rocket will build up a speed of 18,000 mph before dropping off, allowing the satellite to continue on its way. The second method of launching is to send the rocket up on an angle so that at the third stage firing, the rocket will have leveled out at its orbital height while having forward momentum.

Two-stage rockets date back to 1946 when General Electric used a WAC Corporal missile mounted on a German V-2 missile. In 1949 one of these two-stage rockets reached a height of 244 miles, which is more than the minimum necessary for satellite operation. However, the velocity was only 5150 mph, about one-third that needed to establish orbital flight.

CONVENTIONAL TELEMETERING EQUIPMENT

To control and relay back the information picked up in outer space, the equipment used will be similar to conventional devices, and in principal, the same as that used in many previous rockets. The only difference is that weight and space is at a premium; therefore, miniaturized components will be used. The power supply probably will be a Bell Labs. solar battery. The power generated per square centimeter is 0.015 watts. A chemical storage battery, which will be trickle charged by the solar battery, can be used for stored or triggered telemetering.

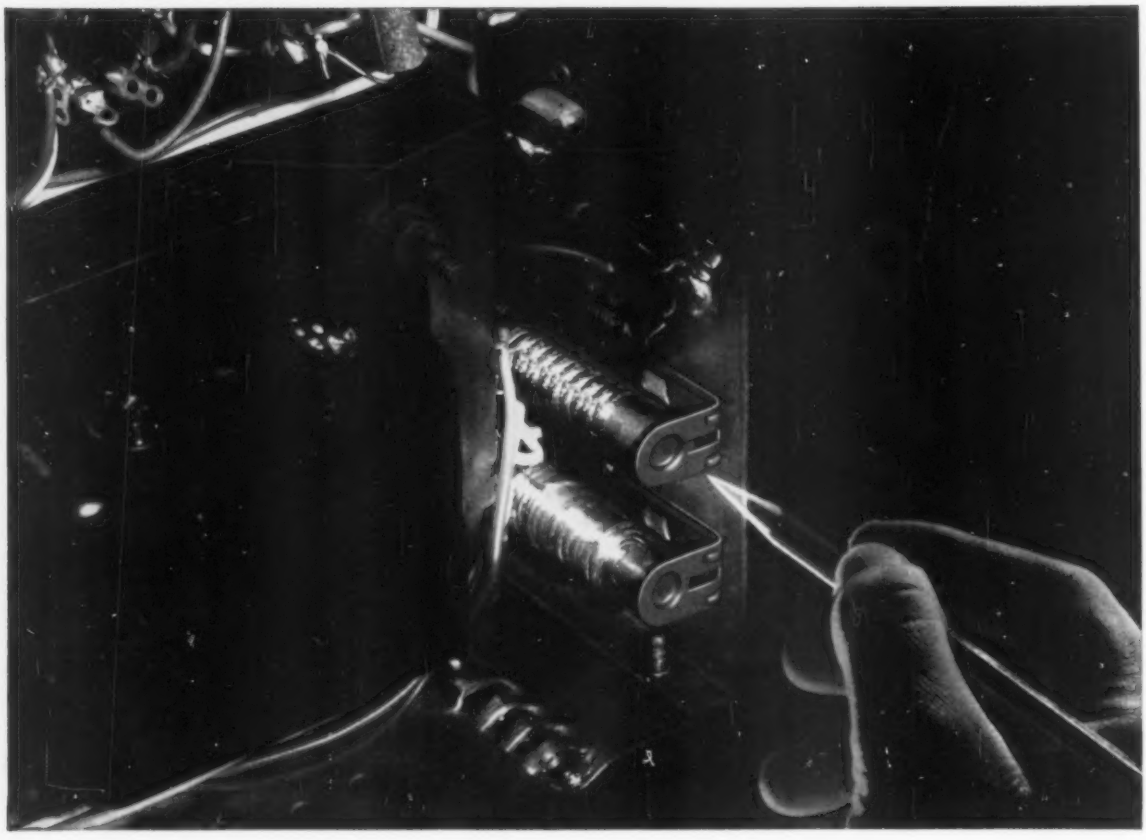
SHAPE AND MATERIAL

Not definitely decided upon is the shape of the satellite and the material from which it will be made. A sphere is perhaps best, for it always presents the same aspect in flight regardless of rotation. A cylindrical shaped object also can be used. When the decision is made, the determining factor will be how it will affect the life of the satellite.

The satellite could be made of aluminum providing its velocity is kept low enough in the dense atmosphere. For the same reason, plastic has not been ruled out. However, if these fail, stainless steel can be used.

INTERSERVICE RIVALRY

As might be expected, the different members of the armed forces want to get into the act with equal fervor. The result is a big squabble which could threaten the entire satellite program. As Dr. Fritz Zwicky, professor of astrophysics at California Institute of Technology, and chief research consultant of Aerojet-General Corp., stated: "All kinds of jealousies and bureaucracies are hampering the satellite program, and there has been too much 'passing of the buck.' We are working slowly, and are not in as good a position as people think." The Navy, nevertheless, has the inside track, with most of the work done at the Naval Research Laboratory.



Engineered by Tinnerman...

SPEED CLIP® simplifies assembly, adjustment and servicing...and saves money!

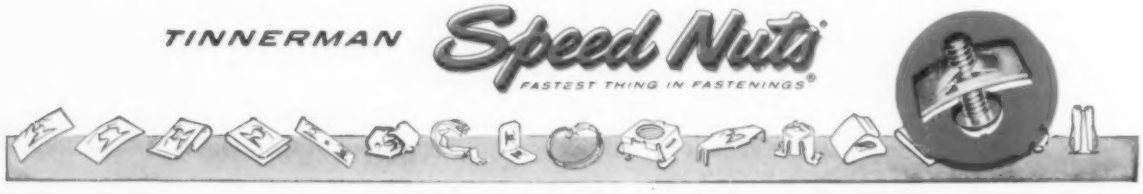
The Westinghouse Television-Radio Division, Metuchen, New Jersey, needed a fastener to fill a complex fastening requirement. Tinnerman was consulted, and developed a *special* SPEED CLIP that fit the job perfectly!

This one-piece, spring steel SPEED CLIP is assembled quickly and easily to the television tuning coil. The SPEED CLIP, with tuning coil attached, is then simply snapped by hand into twin mounting holes in the chassis to lock the unit securely in place. This SPEED CLIP cuts costs on the assembly line. And it permits fast and simple adjustment of the television tuning coils, eliminating the problem of blindly searching with a screw driver for the slot of a special hex nut.

Find out how SPEED NUT Brand Fasteners can help you improve your own fastening methods. Ask your Tinnerman representative for details of our Fastening Analysis Service or write for Bulletin No. 336.

TINNERMAN PRODUCTS, INC., Box 6688, Dept. 12, Cleveland 1, Ohio
Canada: Dominion Fasteners, Ltd., Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois, (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

TINNERMAN Speed Nuts® FASTEST THING IN FASTENINGS®



Standard or Special

BECAUSE ENGINEERS MUST BE ACCURATE they tend to demand that everything must be just so. Those engineers who temper this urge for perfection with sound judgment usually are successful.

In the very beginning of the development of a design the objectives to be achieved by the mechanism, machine or product, are specified. It then becomes the job of the engineer to achieve those objectives. In the majority of instances this is not extremely difficult. Well known fundamentals and principles will indicate the methods by which the end results can be attained. The final step is to translate these methods into the linkages, devices or components that will give the desired result.

There are always innumerable ways of walking from a starting point to a distant destination. The same applies when selecting the physical means by which a given objective is to be attained.

The first move in selecting the ways and means of getting to the desired objective is to establish the type of mechanism or component to be employed. Having established this, the designer is tempted to keep right on and design in detail the elements required. Herein can be the starting point of a grievous error.

After the designer has established the method by which he will get the desired end result he should make a diligent search to find out whether or not the required mechanisms or components might not be obtainable as purchased finished parts. In many instances his search will be rewarded. The next step is to determine the relative costs, keeping in mind that the purchased part is a perfected design built by specialists.

In comparing the cost of the purchased part with the estimated cost of manufacturing it in the company's shops, it is extremely easy to underestimate the engineering design costs involved. Only too often these costs are figured as the wages only, without the addition of overhead. Or the overhead charged might be much too low.

In the average engineering department the total cost of a design will be the hours spent times the hourly rates of the engineers involved and that result multiplied by a factor ranging from 2 to 2½. This last represents overhead, including the cost of all the fringe benefits, supervision, supplies, rent and many other items.

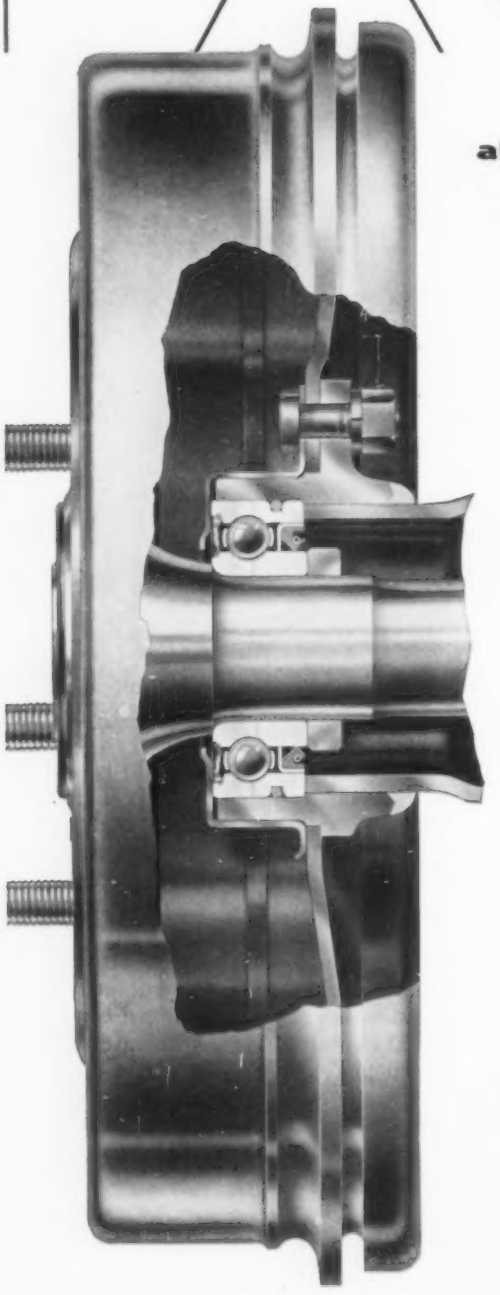
In many companies the engineering department can save the management a great deal of money by seeking and finding purchased parts to be used instead of going to the expense of designing special parts. And the purchased parts are of established quality and dependability. An engineer who is awake to this situation might save his company several times the salary paid him and thereby lay down the stepping stones to his further success.

George F. Rockwell

FACTS

about

NEW DEPARTURE
BALL BEARINGS



New Departure's Sealed-for-Life Rear Wheel Bearing is press-fitted to its seat—without need for locknuts, threads, or grooves to weaken the shaft.

30,000,000 rear wheel bearings can't be wrong!

This New Departure rear wheel application is an outstanding example of the advantages ball bearings provide designers for increased dependability at lower cost.

As proved more than 30,000,000 times, New Departure Rear Wheel *ball bearings* permit the design of simpler, stronger, more foolproof axle mountings . . . and the savings ball bearings bring in machining, assembly, and axle parts cut production costs substantially.

New Departure Rear Wheel Bearings, mounted this way, eliminate locknuts, threads, and grooves—never require adjustment. They are "Sealed and Lubricated for Life," giving the service-free qualities that have earned them the description *"built to be forgotten"* . . . and a reputation of outlasting the product they serve.

Remember—leading manufacturers depend on New Departure for outstanding *quality and engineering service.*

NEW DEPARTURE SEALED BALL BEARINGS PROVIDE MINIMUM MAINTENANCE—LONGER LIFE

New Departure offers a wide variety of sealed ball bearings for applications of every kind. Full details on request.

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

Germany's Amazing Comeback

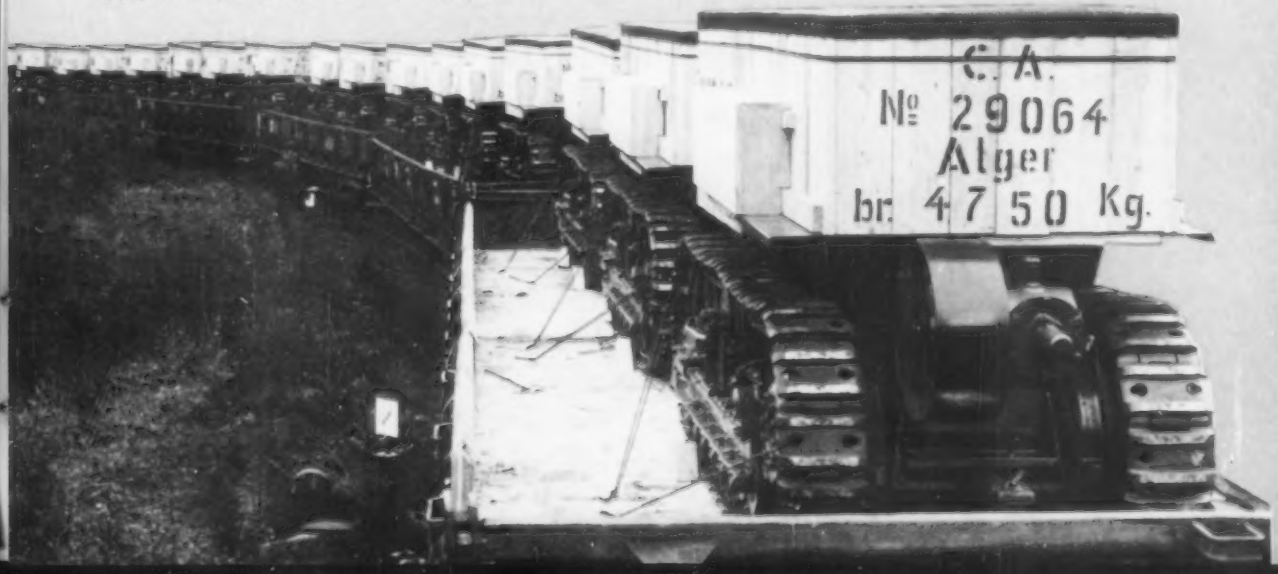
National recognition and application of the powers of education, engineering and energy are speeding the nation to rapid recovery, and then some.

GEORGE F. NORDENHOLT, *Editor, Product Engineering*

Never in world's history has a bombed, burned, defeated, partitioned and ravaged nation staged in ten years a comeback such as that of Germany. Here is an eye witness account of what Germany has done and is doing, and the national spirit that stimulates the people to produce. Conferences and associations with German educators, industrialists, and engineers and visits through factories, schools, government bureaus and engineering laboratories furnished the facts, figures and background of this amazing story.

The author is indebted to Gerald W. Schroder, McGraw-Hill World News, for information on the operation of the Max Planck Institute and the German schools.

Copyright 1956 by McGraw-Hill Publishing Company, Inc.



Germany's Amazing Comeback

NEWSPAPERS AND MAGAZINES are describing the amazing comeback of Germany. Only ten years ago it was commonly considered impossible. At that time, according to experts, only by miracles could Germany rebuild her bombed and burned cities, her demolished factories and blasted chemical plants. Even then she would still have to replace the machinery and equipment that had been confiscated by the victors. "Not within our lifetime will we see Germany again in the front ranks of industry and commerce," said many commentators, only ten years ago. But it has happened.

German industry is thriving again. German trade is reaching out to all corners of the world. The slogan "Made in Germany" is reappearing on farm machinery in Egypt, India, South America and many other lands. Construction machinery in Africa and machine tools all over the world bear the stamp or the earmarks of "Made in Germany." German cutlery, plastics, chemical products of many kinds, are finding their way to many foreign markets. What was deemed by many as impossible in 1945 is now an accomplished fact. Germany as an industrial nation, is now an important factor. Her 1955 industrial production is more than twice that of 1937, and in tons of steel produced in 1955 she will rank third, or possibly second.

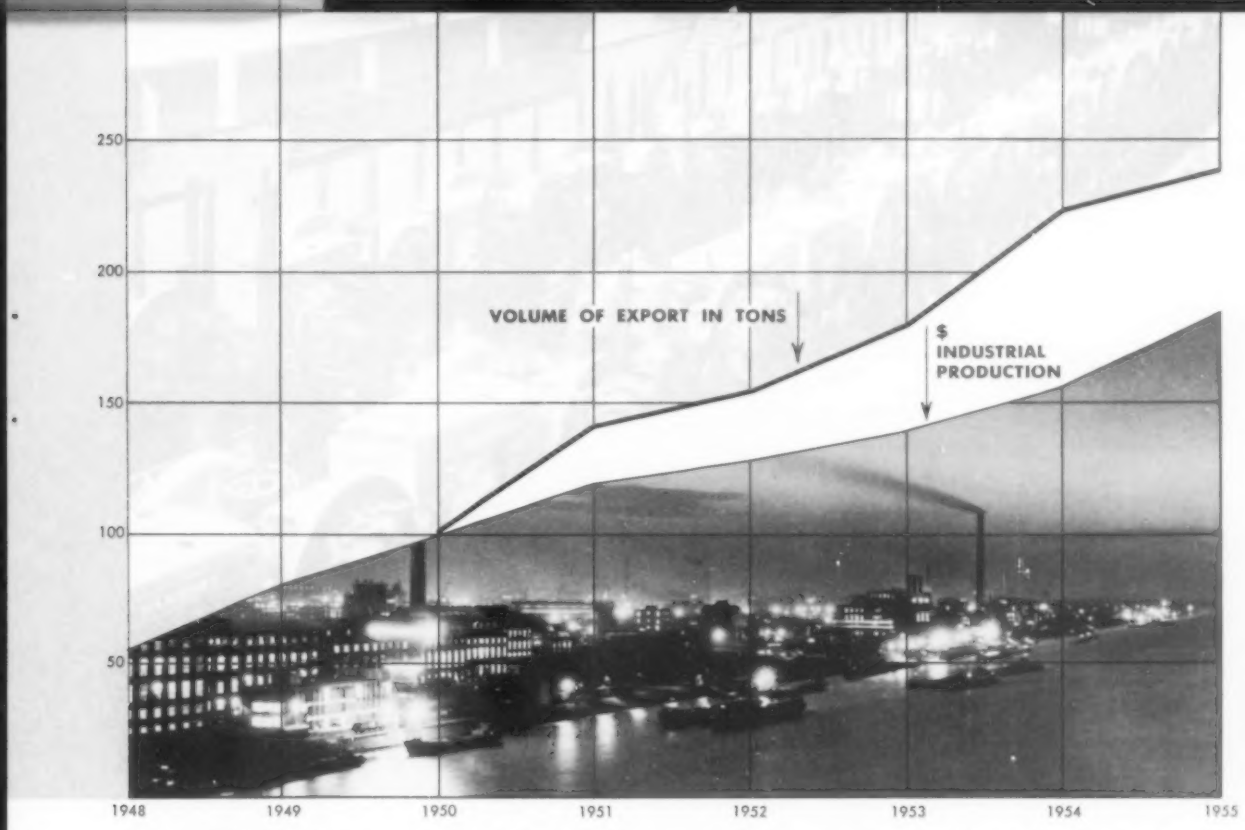
The tremendous impact that Germany's resurgence is having upon world economy is just beginning to be felt. British steamship companies are giving contracts for the construction of oil tankers to German shipyards. The German Volkswagen will soon be assembled in a New Jersey plant. A partly German owned plastics plant is being built in St. Louis. The German Lufthansa has received a U. S. franchise permitting them to carry freight and passengers between U. S. cities and Europe and South American cities. The Hamburg American Line and the North German Lloyd are being revitalized and soon again will have luxury liners plying between American and German ports and freight steamers and tankers carrying cargos all over the world.

How can this be possible? What is it that has enabled this defeated, conquered, subjugated, bisected and almost totally destroyed nation to rise up out of the ashes of its ruins and in only one decade again become a power that must be recognized?

One thing that Germans recognize is the essentiality of operating under a leadership. This is both an asset and a liability. Their downfalls of the past can to a great degree be attributed to the German trait of willingly and even blindly submitting to leadership that promised much. In Adenauer the Germans have recognized a man who will fight for them, who will resist demands of the victors but yet is trusted and

Germans are convinced that education is the most powerful force in the building of a nation. Here is a part of the Technische Hochschule Aachen. Like Cal Tech and M.I.T., not much campus and no stadium. Laboratories and buildings are more important.

PHOTO BY FRANZ MATZKOWSKE, AACHEN, GERMANY



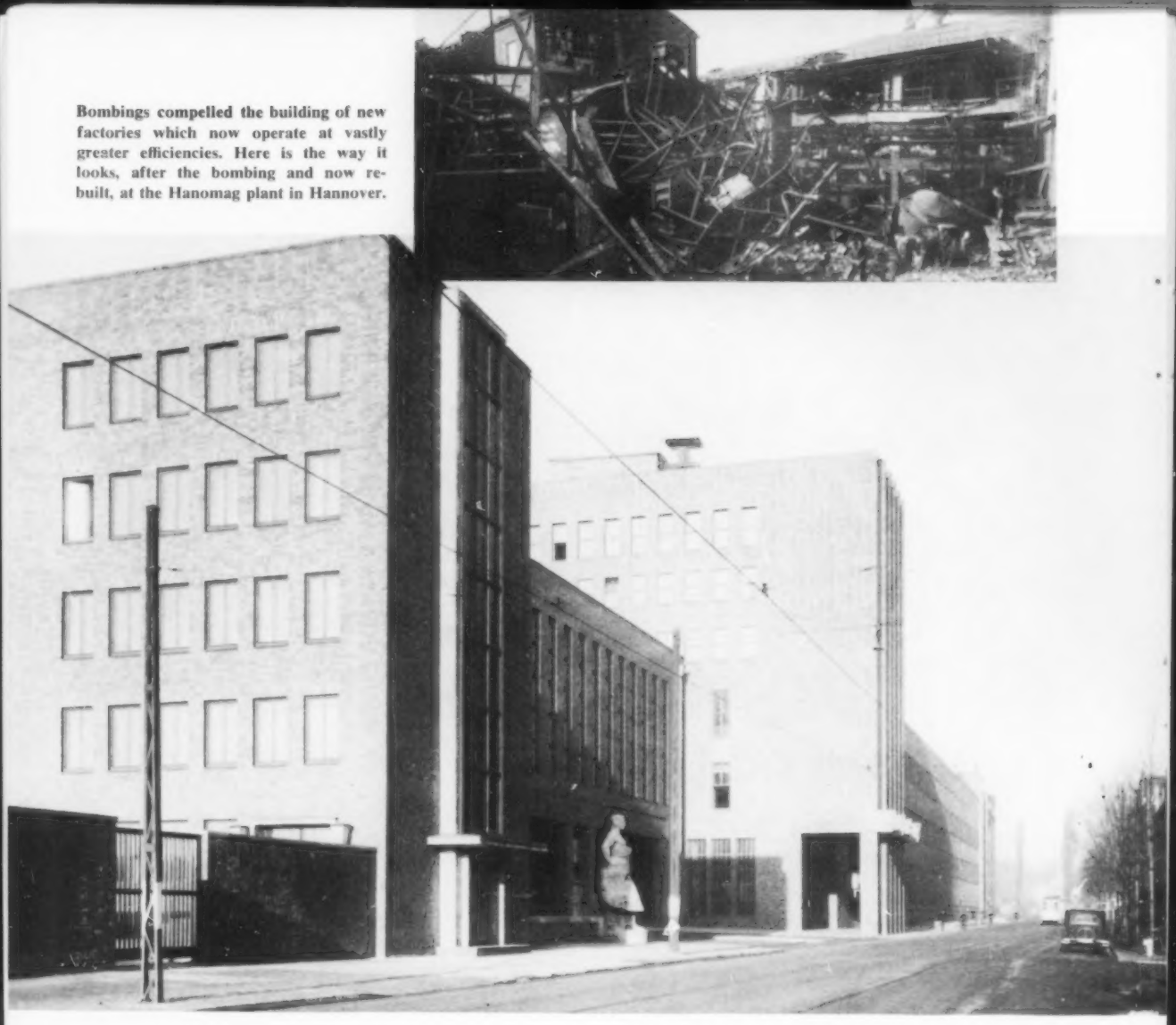
German trade is reaching out to all corners of the world – tonnage has increased 140 per cent since 1950. In the same period, industrial production went up 85 per cent.

This seems to belie German prof's complaints of shortage of lab space and equipment. Here are students at work in the electron microscope lab of the Technische Hochschule Berlin-Charlottenburg. The professional looking white coats have many implications.

liked by them. They look to him as the man who will show the way to a return to normalcy and he is doing it. Though they wholeheartedly disagree with Adenauer on a 500,000 man army, they support him almost unanimously on all other points.

Politics does not build a nation. And no nation in the world knows this better than Germany. Long before Bismarck welded the German principalities and free cities into an empire these peoples had learned that the only measure of prosperity and security is the productivity of the people. They recognized that illiterate people are poor producers, that education is the greatest single force in the building of an empire, that science is the mother of all material progress and that engineering is the medium by which the discoveries and concepts of science are converted into products, processes and services useful to man. Only thereby, believe the Germans, can a nation hope for a more abundant life and greater security. It is the code by which they live.

In the old Germany, hard work, the satisfaction of knowing and being able to teach, and the glory of being a professor, were all drilled into the every-



Bombings compelled the building of new factories which now operate at vastly greater efficiencies. Here is the way it looks, after the bombing and now rebuilt, at the Hanomag plant in Hannover.

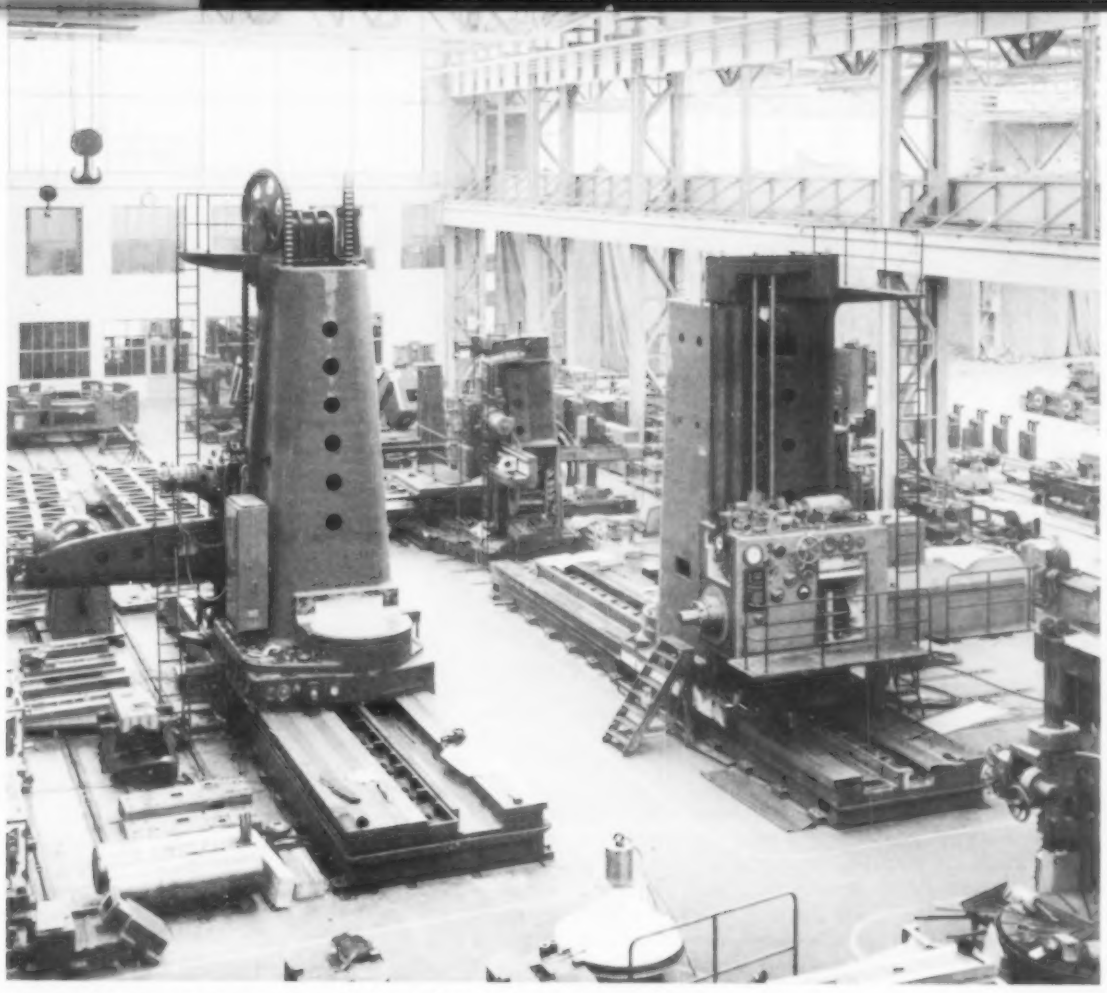
day life of the everyday German. Government and society joined in making the title "professor" the highest in the land. Any man who possessed it was welcomed, and indeed honored, in the highest levels of society. The government subsidized such men to seek more new knowledge and develop new techniques.

Postwar Germany reflects all the fundamentals and all the precepts that were so firmly established in pre War-I Germany. Science and engineering are considered supreme and the teaching thereof, the professorship, is the highest estate to which a man can aspire. Scientists and engineers direct the industrial enterprises of the nation because it is a national axiom that only scientists and engineers can know the possible and gage the impossible in industrial production and engineering operations. The adoration of education, the irrepressible urge to work and the impulsion to unite in national efforts explain why German industry has grown to its present heights in less than a decade after the nation was a shambles of blasted and burned cities with most of its industrial machinery and equipment confiscated; a country conquered, split, leaderless, and facing a hostile world.

TO THE VICTORS WENT THE SPOILED MACHINERY

Scientific knowledge, engineering abilities, technical know-how, and the will to work have rebuilt Germany. Ironically, the nation was favored by the blasting of its factories and the confiscation of its production machinery and equipment. It was a blessing in disguise.

"The British and American Bombers did what our most courageous capitalists would not have had the courage to do. They blasted and burned our factories so efficiently that we were compelled to rebuild most of them entirely new. Naturally, when we planned our new factories we put into them the latest and best ideas of our foremost plant and production engineers." So in effect said Herr Willi Wallrodt, the plant manager of Schiess, the great machine tool builders in Düsseldorf.



The new Schiess A.G. plant at Düsseldorf is typical of the new German factories — much window area, lots of natural light, and spaciousness. As the plant manager expressed it, "We give our men a chance to stretch."

Assembly line production of caterpillar type tractors at the Hanomag plant emphasizes the typical spaciousness and good housekeeping of the German factories. Basically, the assembly operations are the same as used in American plants.

And he certainly did not exaggerate.

The new Schiess plant consists of spacious shops with fine natural lighting, the latest in artificial lighting that man has devised and with plenty of room to make possible "good housekeeping." The washrooms for the shopmen of Schiess could well compete with the finest Turkish baths in New York City. Private showers, individual porcelain wash basins, foot bath basins and also porcelain bathtubs for those who feel they need a hot soaking.

When it comes to shop equipment, the German factories are in an enviable position. Naturally, the demands of war wore their machine tools almost to the point of making them useless. At the best, they were terribly inefficient. Then came the Russians, French, English, and in a few instances the Americans, and took away almost all the wartime worn out machinery. Much of it was virtually junk. To the victors went these "spoils." German production engineers first cursed and ground their teeth—and then rejoiced. How else could they excel in production other than with new machines that were more efficient? That is how it came about that Germany today is competing against the rest of the world with the advantage that Germany has new plants and new machinery of highest efficiency. Add to that their boundless will to work and it spells productivity and production efficiency that dismays competitors.

THE CHANGED ATTITUDE

According to an American engineer who has spent many years in Germany, the German engineers have over the past fifty years changed their attitude toward foreign engineering considerably, especially American engineering.

Prior to World War I German engineers acted in a very superior manner, as though they knew it all. No one could tell them anything. After World War I the German engineers bethought themselves that perhaps they could learn something from American engineers. During World War II German engineers began to realize that they could learn much and today they are seeking to learn all that they possibly can about American, and other foreign engineering and know-how.

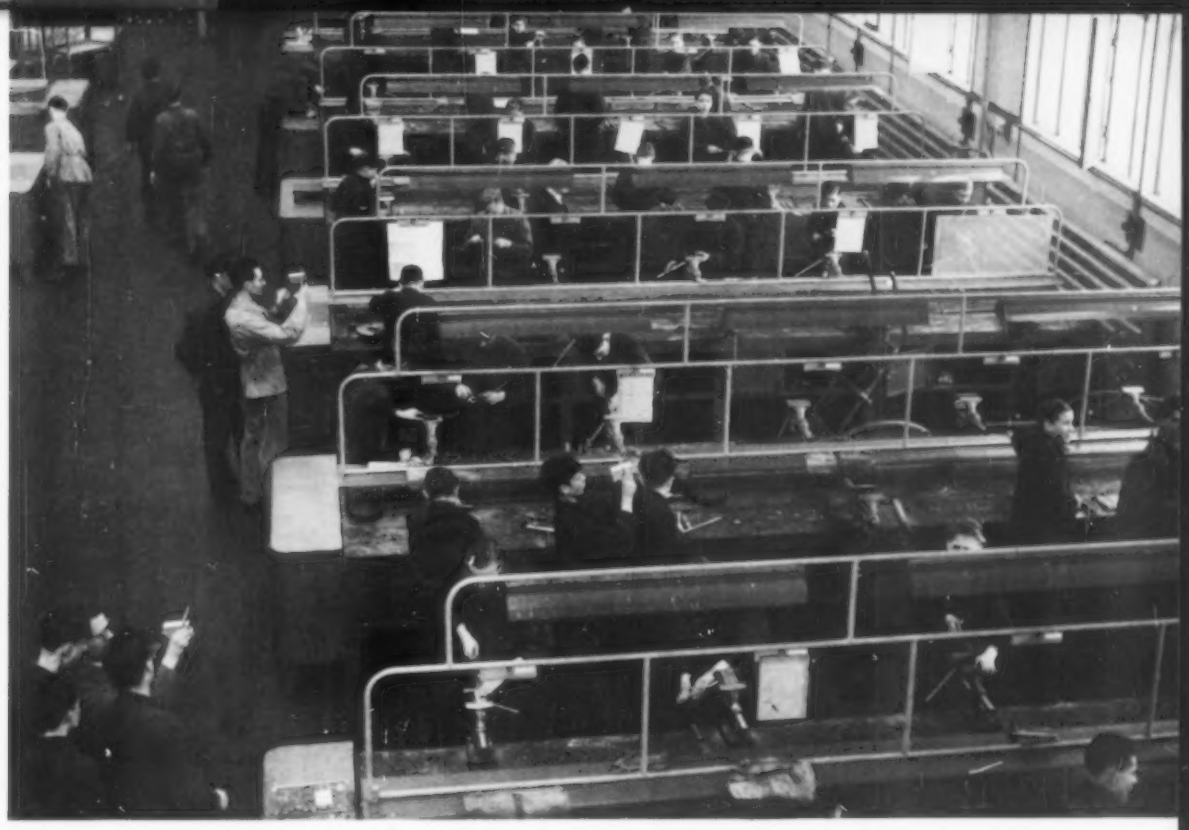
This is borne out by an experience I had in Hannover, Germany, in July of this year. I spent two days at the Hanomag plant where they manufacture tractors and farm machinery. In the evening of the first day I was entertained at dinner by the chief engineer and two of his associates. We talked about design concepts and design philosophies. And on the following day we talked some more about engineering design principles and German versus American applications thereof. From my friends I learned a lot about German design philosophies. We swapped many ideas, many fundamental concepts.

Greatly was I surprised when in leaving Herr Diplom Ing. Werner Zarnack, chief engineer of Hanomag, he said to me: "Herr Nordenholt, I am afraid that I have not given you much that you can print in your magazine, and that humiliates me because I and my associates have received from you many new and valuable viewpoints concerning engineering design as practiced in the United States."

When I reflected on what Ing. Werner Zarnack had said and our long discussions, it occurred to me that each of us had soaked up much concerning the other one's engineering philosophy.

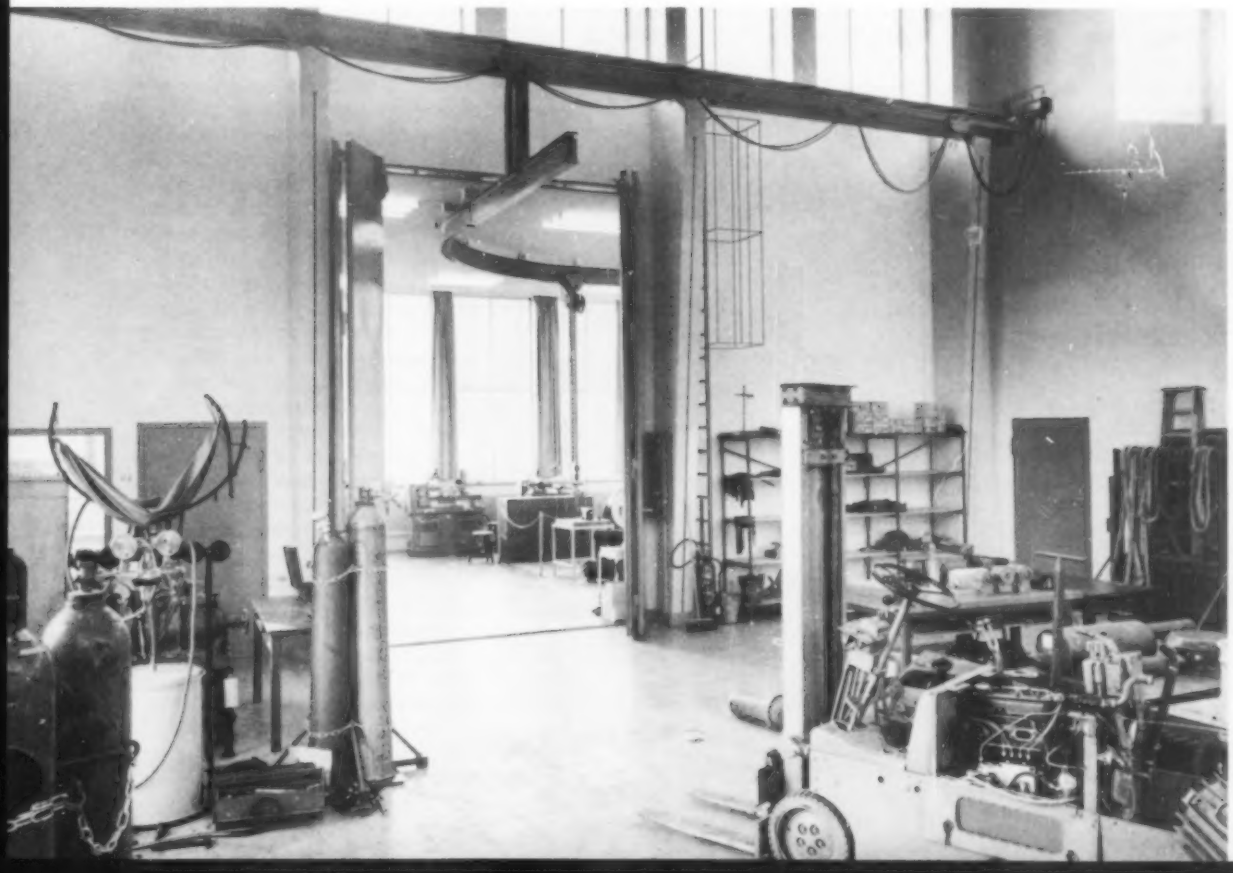
From my discussions with Ing. Werner Zarnack, Dr. Kühn of Menck and Hambrock in Hamburg, Dr. Gunsser of Gebrüder Heller, and Works-Director Willi Wallrodt of Schiess and many others, I was able to get a picture of the forces and powers that are rebuilding Germany. To me it is obvious that the country's industrial activities are being directed predominantly by scientists and engineers. There seems to be an almost uncanny leadership directing the na-

Among groves and fields in Braunschweig, the Bonn Republic quickly established in 1947 the Physical-Technical Federal Institute, the counterpart of the United States Bureau of Standards, and serving both East and West Germany.



Industry contributes much to the German education which goes down to the "grass roots." Here is a view of a part of the apprentice school of the Phoenix A.G. Almost every sizeable plant operates training courses.

Laboratory at the Physical Technical Federal Institute for testing of electrical components that are to be used in explosive atmospheres.



Says a prominent German design engineer, "We cannot weigh the pounds of thinking that went into it . . . but our engineers took 40 per cent of the weight out of it." This philosophy accounts for much of the low cost of German machines.

tional efforts into channels of greatest effectiveness.

Perhaps it was this type of leadership that was responsible for the early postwar establishment of the Physical-Technical National Institute which is the German counterpart of the United States Bureau of Standards. Prior to World War II Germany had its "Physical-Technical Imperial Institute." The war liquidated it. Immediately after the war there was no bureau of weights and measures in Germany.

In the United States of America there is the United States Bureau of Standards. In Great Britain it is the National Physical Laboratory, and in the prewar Germany it was the "Physical-Technical Imperial Institute." This Imperial Institute had its headquarters in the Charlottenburg area of Berlin and when that city fell to the Russians this Institute ceased functioning.

It was in the following year, 1947, that West Germany swiftly brought into being the Physical-Technical Federal Institute and established it at Braunschweig, a small town not far from Hannover. Here, between groves of trees and stretches of lawns, stand the new modern buildings of the Physical-Technical Federal Institute. Each of the many buildings is devoted to a particular branch of science. All of the laboratory apparatus is new and of the latest design. More than one hundred doctors, diplom engineers and professors operate this establishment under the direction of its President, Dr. Prof. Richard Vieweg and his assistant, Director Dr. Scheibe.

(The February number of PRODUCT ENGINEERING will contain a more detailed description of Germany's Physical-Technical Federal Institute and its activities, written especially for PRODUCT ENGINEERING by Professor Dr. Richard Vieweg, its president.)

The speed with which Germany quickly reorganized its bureau of standards is indicative of the decisiveness and energy with which basic technological and industrial problems were attacked. The Germans were well aware that the bureau was essential to the rebirth of the nation's industry and therefore it had to be esablished with greatest rapidity. Therefore, it was done with no time wasted arguing about it, nor were politics permitted to slow the progress.

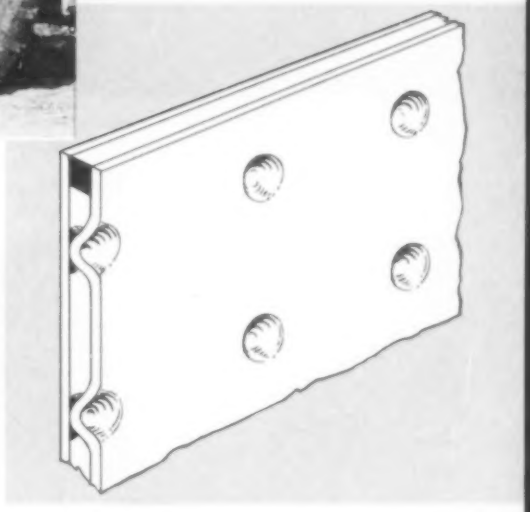
STANDARDS FOR EAST AND WEST

It is interesting that today the German Bureau for Measurements and Weights, organized by the Soviets in 1946 out of a section of the prewar Physical-Technical Imperial Institute which fell into their hands, is now operating in the Eastern sector of Berlin known as D.M.A.G. This bureau and the Physical-Technical Federal Institute, known as P.T.D., take care of all of the standardization of measurements for the whole of Germany, both the Eastern and Western sectors.

Every German engineer knows that he must design not for a production of millions of units, but for the production of hundreds of thousands of units, or only thousands. Thus, the German designer of production machinery knows that he must design a general purpose machine that by "the twist of a wrist" can be made to produce, almost entirely automatically, a vast variety of parts that require that type of machining. Thereby the German machine tool designer develops a machine that can produce most economically any one of a great number of different parts, the change over from one part to another requiring only "the twist of the wrist." In contrast, the American automatic machine tool usually requires new cams, new fixtures, or perhaps a whole new machine, when changing from producing one part to another design.

Another aspect of German engineering design is the attention paid to new production techniques that might materially reduce manufacuring costs. And conversely, Germans spend a great deal of time and energy on developing new and more economical production techniques. German design engineers and production engineers take advantage of these developments at the earliest opportunity.

Tubular construction weldments and hydraulics figure prominently in the design of German machinery. This Hanomag power shovel is a typical example thereof.



This hollow girder or beam of the type used by Menck & Hambrock of Hamburg is made up of two plates and edge spacers, with the plates spot welded at the dimples. It saved much weight. German design concentrates on such material savings constructions.

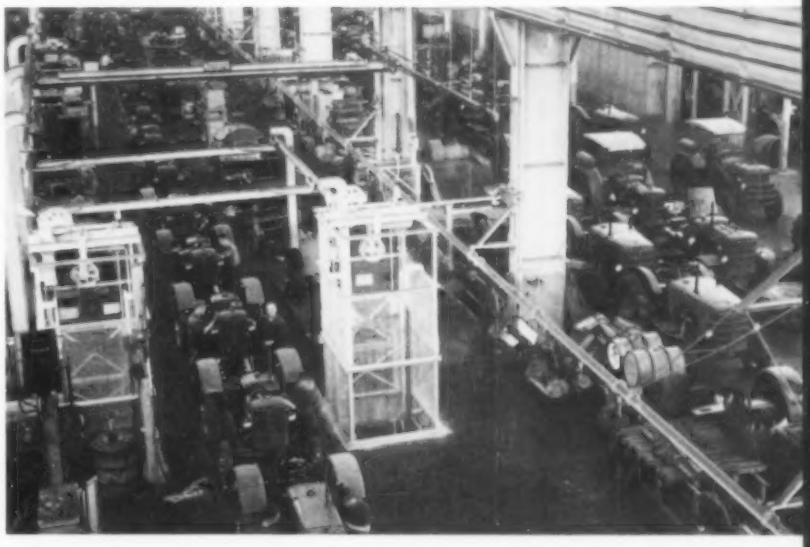
ENGINEERS IN MANAGEMENT

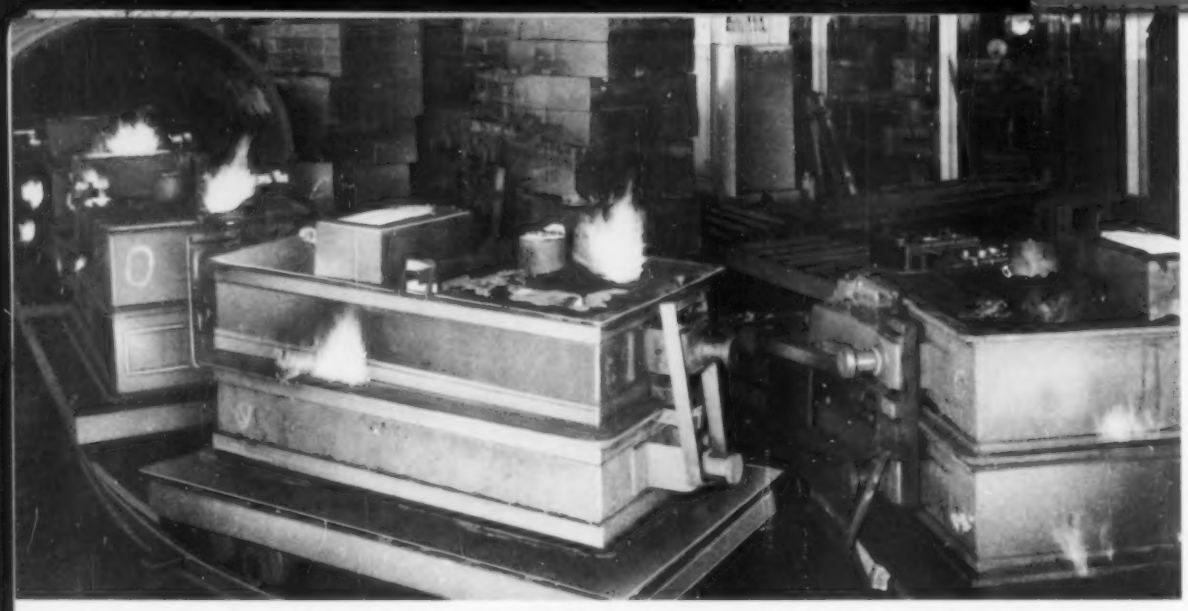
Germany fully recognizes the importance of having engineers manage their industrial organizations. Although quite a few American industries have an engineering dominated management that recognizes the essentialities of science and engineering, as a nation the United States seems somewhat behind Germany in this respect. With reference to engineering education in the U. S. A. the battle rages between "liberal arts" and "specialized training" with some recognition that both are required. German engineers get much of both. They are far better educated in the humanities. Perhaps this partly explains why German engineers fulfill so many important policy-making functions in the industries of their country.

In Germany, the decisions of the engineers rule on most industrial problems relating to science and technology. It is not the economists or sales managers who decide whether or not a welded design is to be used. That is solely the province of the engineers. This partly explains why Germany is in the vanguard of progress in the adoption of new engineering concepts and new production processes.

In talking with the "Ober Ingenieur" of a prominent German manufacturing company, he said, "We cannot weigh the pounds of thinking that went

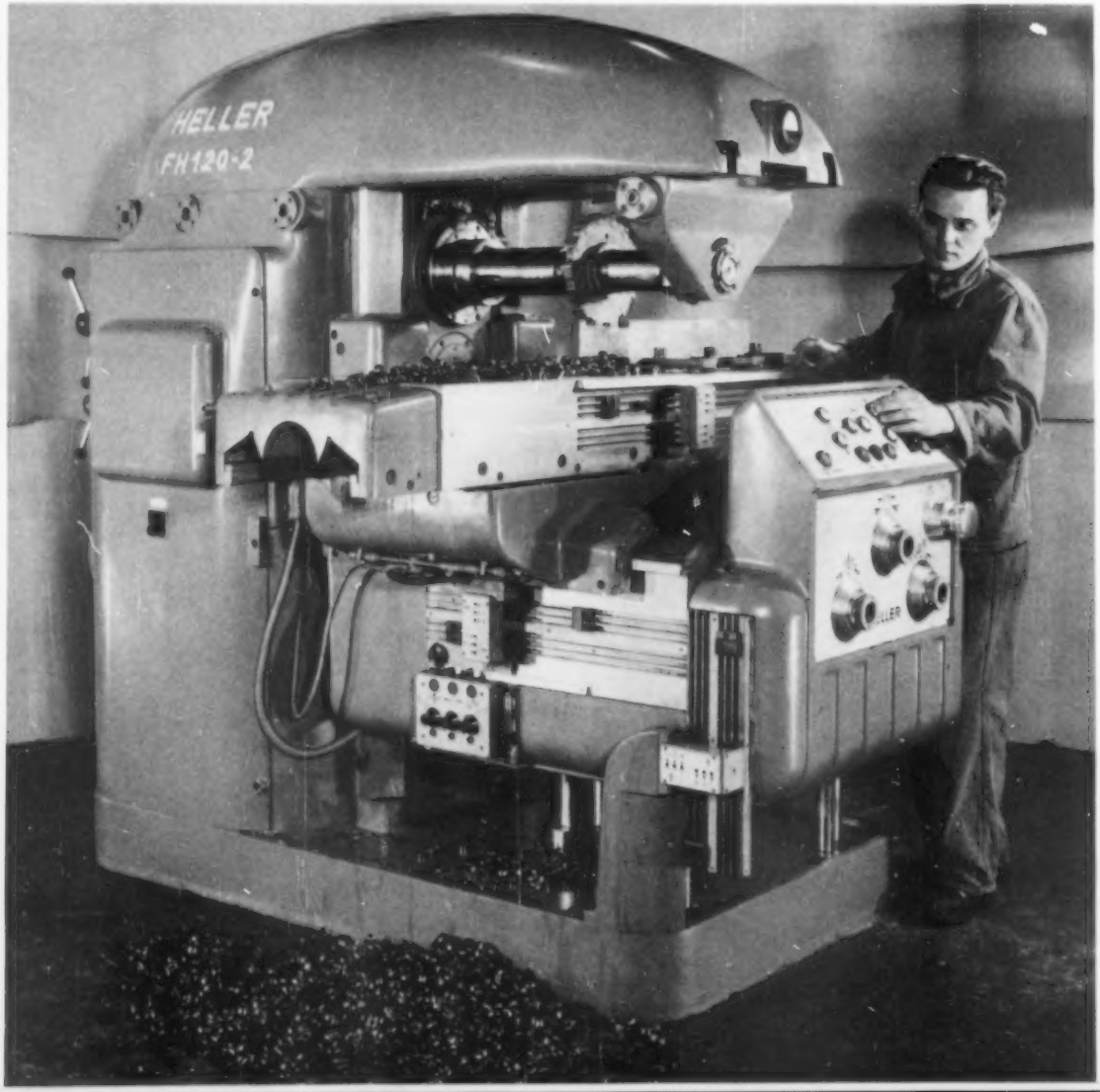
About half of these wheeled tractors being conveyor-line assembled will be exported. The good housekeeping and absence of crowding is typical of most German factories.





German designers are quick to take advantage of new production techniques such as the Croning shell molding process. Here is a typical foundry using it, in many respects quite similar to American practice.

This Heller machine strikingly illustrates the application of pictorial symbols on the control panels. Instead of having separate signal lamps, the buttons glow upon being depressed to indicate the circuit condition.



Many German factories export 40 or more per cent of their production. This is essential for the establishment of trade balances in their favor. To do so, the German engineers develop and produce low-price high-quality products.

into the design of that crane, but we do know that our engineers took forty per cent of the weight out of it."

Such a statement speaks volumes. The top management had authorized the additional "expenditure of brains" on the project. Obviously the top management had a sublime faith in the ability of the engineers to take a healthy percentage of weight out of the structure. Incidentally, the top management of that company is predominantly engineers.

Anyone who studies German designs of machinery will be struck by two facts. The German engineers have developed great ingenuity for circumventing what is apparently impossible. Secondly, the Germans spend much time in figuring out how to save a few pounds of material.

At the Menck and Hambrock plant in Hamburg, their chief engineer, Dr. Kühn, showed me their latest design of bulldozer. It was a heavy-duty machine and the side frames would obviously be subjected to heavy loads. Presumably the side frames had to be made of a heavy plate or casting. But instead, the side frames consist of a relatively thin sheet with large diameter dimples about one and a half inches deep spaced about every 12 inches. This sheet is placed against another sheet of the same thickness, the bottoms of the dimples bearing against the surface of the second sheet and then spot welded to it. The resulting construction is about 30 per cent lighter, stronger and more rigid. It is in effect a hollow beam. The thinking and ingenuity that went into this development is typical and not uncommon.

Economically, the great problem faced by German design engineers is to develop a product that can be made most economically even in small or medium lots. This poses many problems and apparently German design ingenuity excels in their solution, just as American engineering leads the world in mass production.

Whenever lots are small in numbers it becomes extremely important that there be the closest possible cooperation and understanding between engineering design and production. In the United States that is demonstrated effectively in the aircraft factories where liaison between design and production is closer than perhaps in any other American industry. But where lots are large in numbers, as in American auto manufacture, this is not so highly important. For example, there can be a great deal of freedom in the design of small parts without appreciably affecting their cost, if the parts are made on automatic machines.

COST PENALTY OF DETAILS

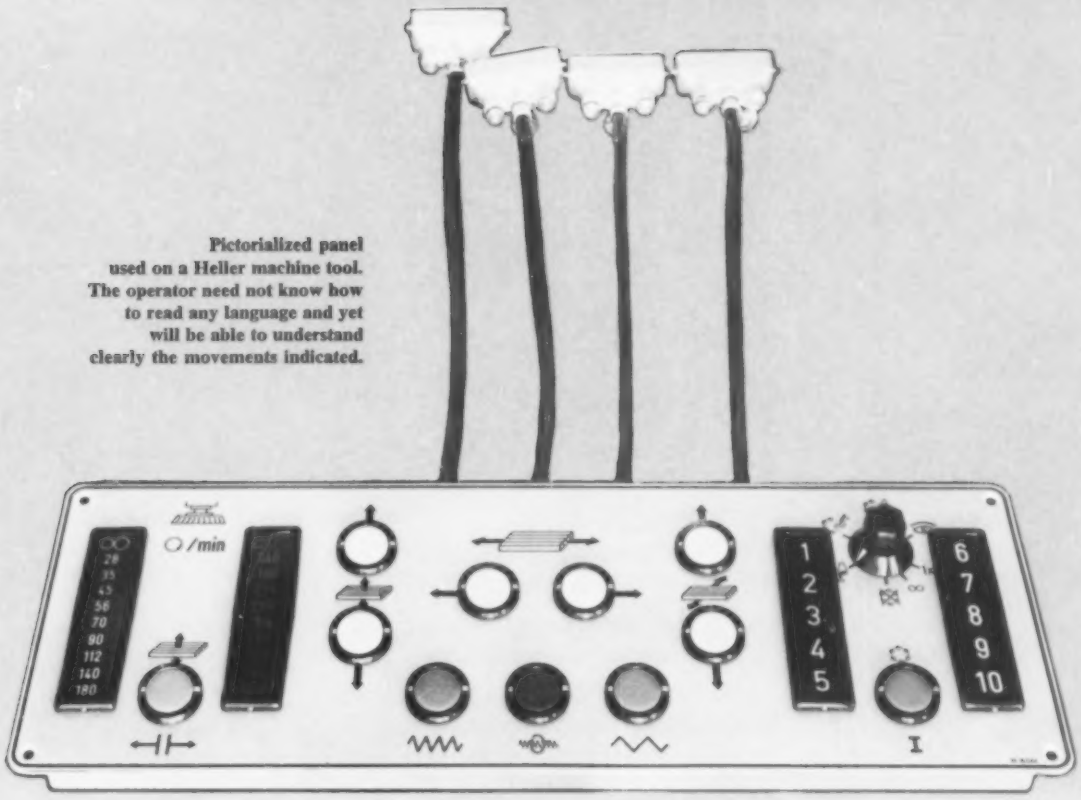
Whether or not there be an added shoulder, bevel, counter-bore or knurling usually does not change noticeably the cost of producing the part on automatic machines. An additional tool may be required, but the quantity of pieces produced per hour usually will be about the same. Hence the cost penalty for an unnecessary embellishment is practically nil. That is not so when only a few parts are to be made on general purpose machines. The smallest detail might add much to the cost. That is why the German designers are trained to study the most minute details with great care.

Export is the major aim of German manufacturers. They need trade balances in their favor. Most of the factories export 40 or more per cent of their production. One factory exports about 60 per cent of its production of farm machinery and tractors. Another company exports 40 per cent of the bulldozers, scrapers and power shovels it makes. The machines go all over the world. That poses a problem of devising instruction plates that can be read in any language. The solution found is interesting.

In the rooms of first-class German hotels one finds a small panel having two or three push buttons, the pressing of which will call a waiter, a maid or a porter, depending on which button is pressed. The problem was to indicate to the Englishman, Frenchman, American, Brazilian, or any foreigner who could not read German, which button to press to get what he wanted. The solution adopted was the pictorializing of the buttons. Next to the porter button one sees an outline sketch of what is obviously a man carrying a valise. The maid's button

In most German hotels
the push button panels are pictorialized
to indicate—"waiter, maid or porter."
The same idea is used for name plates
and instruction plates on machinery.

Drafting rooms in the German technical high schools can well be the envy of American educators. Note the curved ceiling to achieve uniform natural and artificial lighting.



Pictorialized panel used on a Heller machine tool. The operator need not know how to read any language and yet will be able to understand clearly the movements indicated.

is indicated by a woman with duster and a waiter is pictured as a man carrying a tray with glasses on it.

Whether the pictorialized push button panels in hotels came first or whether it was the pictorialization of instruction and direction plates on machinery that came first, is of no consequence. The fact is that German engineers adopted pictorialization of direction plates. This solves many problems. It is not necessary to write the instructions in many different languages and make a great number of different plates, with the ever present possibility of confusion. And perhaps of even greater importance, even a workman who is so illiterate that he cannot read at all can still understand the pictorialized directions on the plate.

Pictorialized directions are also used on machine tools, the pictures being so positioned with respect to the buttons that the meaning is strikingly obvious. The table of a milling machine, planer, or other tool may be pictured with a button just below each end of the sketch, with an arrow pointing the direction in which the table will move. Pressing the button at the right end causes the table to move to the right. Pressing the left-hand button moves the table to the left. A sine curve below the button indicates slow speed or feed. A high frequency curve indicates high speed. A few American machine tools use this method.

Another German innovation is the illuminated push button which does not complete the circuit switching until the button is released by taking the finger off. If the operator discovers he is pressing the wrong button he can push a reset or a stop before he takes his finger off the button. In that way the damage that might have been done in pressing the wrong button might be avoided.

Signal lamps are beginning to make their appearance more extensively on American machine tools. Presumably as the controls become more in number and complication, the use of circuit indicators will have to become more general. The use of push buttons that glow after being pressed has been used for some years on passenger elevator buttons. They have the advantage of showing the circuit situation.

ENGINEERING EDUCATION

As in some other countries, there is a shortage of engineers in Germany. This in spite of the fact that the Germans use engineers only for engineering work. The Nazi reign killed off much research, advanced learning and technical education. The war took almost all the young boys out of school. Many of the best brains fled the country and many were killed. But the national thirst for scientific knowledge remained unslacked.

German engineering training and education begins in the grade schools, as it does in all countries. But much more is demanded of the German students all throughout their elementary and high school education than is required of American students. In Ger-

The national thirst for scientific knowledge remains unslacked. This view of one of the auditoriums in the Technische Hochschule Aachen is indicative of German attention to details as applied to education. PHOTO BY FRANZ MATZKOWSKI, AACHEN.

many schools are strictly institutions for the learning of liberal arts, basic sciences and applied technology. School years are twenty per cent longer, and so is the school day.

In the German equivalent to the American high school they teach neither auto driving nor square dancing. It is still a common sight to see boys and girls going to school carrying a schoolbag. Homework is assigned and parents see to it that the work is done. School discipline is strict. The teacher is truly a schoolmaster. Germans do not subscribe to the adoration of the child except as praise might be truly earned as a reward for performance.

Modern languages plus Latin or Greek and other "humanistics" are included some place or other in the prerequisites or in the engineering courses. At what is called the university level in America, the German engineering students, and the same is true in England, pursue their course entirely at their own initiative. Attendance rolls are not kept. There are no periodic "quizzes" or even recitations. But the final examinations, which are both oral and written, are extremely searching, thorough and comprehensive. Only those who have properly mastered the subjects can hope to pass. Herr Ingenieur truly earns his degree.

In spite of the extreme hardships created by the war and its results, it is generally agreed that the educational standards in the German technological institutes are again as high as they were in 1933 when the Nazis began their steady undermining of Germany's greatest strength, her institutes for engineering education.

Germans place a tremendous emphasis on the value of scientific knowledge. The most powerful basic science research organization in Germany, and probably the world, is what is known as the Max Planck Society for the Promotion of Science. The Max Planck Society was founded February 26, 1948 in Goettingen, the charter members including twenty-six of the Kaiser Wilhelm Institutes that were situated in the British and American zones of Germany. On November 18, 1949, the former Kaiser Wilhelm Institutes in the French zone were incorporated into the Max Planck Society. Up to now there has been no contact between these institutes of the Max Planck Society and the Kaiser Wilhelm Institutes that were in the Soviet zone of Germany.

The final liquidation of the Kaiser Wilhelm Institute and the transfer of its assets to the Max Planck Society was agreed upon in 1951. The aims and principles of the Max Planck Society coincide exactly with the Kaiser Wilhelm Institute, which had operated for many decades prior to the war. The directors of the Max Planck Society, now numbering 35, operate under complete academic freedom and there are no restrictions placed on them as to either the choice or the method of execution of their scientific work.

In 1949 the eleven "states" or "Laender" of the German Federal Republic agreed on a method of joint financial support of the Max Planck Societies. 15 million DM was voted for the institutes, to be spent by them on projects of their choice.

Leadership in science and engineering is the foundation upon which Germany is rebuilding and booming. The driving power is the tremendous will

German industry is booming again. Here is view of Hannover with the Hanomag works in the foreground. Close inspection will reveal some of the scars of bombings.

and desire to work, to build, to create. It is of the nature of a compulsion that stems from within, an urge than cannot be stifled. It defies analysis. What makes it? The Dutch and Scandinavians are about the same, so it cannot be a matter of nationality. Environment and heritage seem to be the only answers.

It does not require a visit to factories to get the impact of German industriousness. One sees it and hears it in the ceaseless work of rebuilding the cities. From the three o'clock June sunrise in Hamburg till ten o'clock when it begins to get dark, one hears the sawing, hammering and the sound of pick and power shovel. Steel is scarce so reinforced concrete is used almost throughout, and the chug-chug of the concrete mixers is almost ceaseless.

The new buildings are higher; the streets are wider. In Munich they decided to widen a street twenty feet. All the buildings except one on one side had been leveled by bombs during the war. So the Germans tore down the one untouched building and commented, "If the Americans were as

The ceaseless work of rebuilding German cities – the buildings are higher; the streets are wider. It is the counterpart of the activity seen in factories.

Children playing on the street in front of these monstrous looking ruins did not know that they are the remains of the "Ministry of Transportation" headquarters of the Nazi regime. In one decade the memory of its collapse already begins to vanish.

efficient as they boast to be they would have hit this building also and we would not have had all this work of tearing it down." It is a kind of humor in which Germans delight.

Germany revitalized, Germany rearmed! What does it forbode? Will it bring on another war? Even the Germans do not know the answer. Nor is it given to any human to see beyond the veil that hides the future. There are many forces developing, some for peace and others for war. But here are some forthright expressions from waiters, taxicab drivers, porters, railroad conductors, engineers, business men and doctors of philosophy.

"We do not want the 500,000 man army. It is a move toward a war in which Western Germany's army of 500,000 would be killed by, and would be killing, East Germans. . . . The Iron Curtain would be the only reason, now foreseeable, for Germans going to war again but this generation would not go to war under any circumstances or for any reason. . . . Germany suffered close to total destruction in this last war. We do not want to take another chance. . . . We foolishly listened to Hitler's promises and by the time we saw where he was leading us it was too late. . . . I served in the SS and the first chance I get I want to go after the Russians. . . . We are building rapidly but will build more rapidly. We must create 10,000 new jobs a day for the refugees that are daily streaming into Western Germany from the Eastern Zone. . . . There is an inner compulsion that makes us work whether we feel like it or not. Will we get so far ahead that some competing nation will resort to force to compel us to stop producing? . . . This generation will not fight again but what of the next generation?"

THE NEXT GENERATION

What of the next generation? I stood before the ruins of what was the Ministry of Transportation in Munich. Not knowing what building it had been I asked some 10 or 12 year old children playing on the street. They did not know! How could they know? The building had been destroyed before they were born! The next generation has already arrived! Where will it go? Germany today is on the march. It is not the goose step of militarism but the forward march of science, engineering and industry. Will this next generation fall in with that parade and build the nation to even greater heights? Will Germany sit in councils of nations that will strive to bring an everlasting peace through good will to all men? Is it conceivable that a nation that has suffered destruction and defeat such as has been administered to Germany would ever again submit to being a party to a war? That is hardly conceivable, but there is one highly disturbing situation.

One of the finest educated men I met in my travels through Germany posed the question:

"How long would the American people tolerate an iron curtain stretching from Chicago to New Orleans?"

My answer was, "Not a minute longer than we had to!"

To which he answered, "With Germany it will undoubtedly be the same, but the minute will have to stretch out until the present generation no longer counts. We today will not agree to war for any reason that is at all bearable. But I cannot visualize the next generation not going to war if that were necessary, to reunify Germany."

O-Ring and Gland Design for HIGH TEMPERATURE SEALS

Factors affecting the design of glands for sealing reciprocating or rotary motion under extremes of heat and pressure; requirements for seal material, gland design, lubrication, loading and surface finish.

T. J. McCUISTION
Rubber Products Div., The Parker Appliance Co.

As operating conditions become more severe, the design of glands for O-ring packings becomes more complicated. High temperatures cause most rubber-like materials, even Teflon, to soften and the extrusion problem becomes critical. The combination of abnormal temperatures and high pressures may require not only a special material but also the development of a more complicated gland or seal.

Glands for high temperature may be divided into specific categories as follows in the order of design difficulty:

1. Reciprocating motion
   a. Pneumatic (gas on both sides)
   b. Liquid on one side (such as a rod seal or an accumulator seal)
   c. Liquid on both sides (similar to those of a rod seal but not as severe)
2. Rotating motion
3. Stationary elements

Glands for Sealing Gases

The high temperature gland most difficult to design for perfect sealing is that for sealing gases under high pressure. In addition to the problems encountered in sealing liquids, seals for gases are harder to keep lubricated. Oxygen attacks most of the organic rubber-like materials, causing more rapid aging and deterioration because a greater amount of oxygen per unit area of exposed seal is present. Also, gases permeate where liquids cannot.

Because all organic materials are permeable to some degree it is necessary to have relatively porous seal materials so that entrapped gas can be rapidly expelled. Otherwise blisters, ruptures and chunks will be blown out of the seal when rapid changes in pressure occur.

Obviously, because of these differences in requirements, O-ring materials such as used in hydraulic systems cannot be used for sealing gases.

Reciprocating Motion With Liquid On One Side

Such a seal may be more critical than the pneumatic seal in an air accumulator because of heat pump action. Local temperature increases as high as 100 F have been found when cycle testing an accumulator at 300 F. Minimized leakage is essential to glands of this category.

The majority of applications that have liquid on only one side are those such as the glands for the exposed rod of a hydraulic cylinder and piston. This gland application is more critical than that for the double-acting piston with liquid on both sides of the seal. Volatilization of the oil from the exposed surface reduces lubrication. Charring of the exposed oil makes the cylinder or rod surface rough or abrasive, thereby cutting the seal.

Glands for Slow Motion Rotation

These seals are easier to design because: eccentricities in motion and surfaces are not as great; the micro-fine grooves in metal are usually in a circular pattern; breathing is seldom encountered; and exposed, dried-out surfaces are not pulled through the seal.

Any type of motion gland seal is more difficult to effect

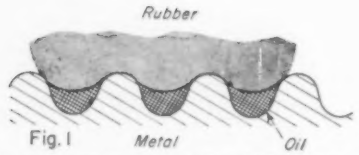


Fig. 1—In order to seal the rubber must extrude into the micro-fine grooves of the metal.

than a static one. The energized, flowable material (such as an O-ring under compression) exudes into the depths of the micro-fine grooves of the metal surfaces to form a seal as shown in Fig. 1. A leak-proof seal is only made when the rubber is almost completely seated. Lubrication is needed to assist the rubber flow into these grooves for even static seals. Low pressure pneumatic, vacuum and fuel O-ring seals frequently leak if no lubricant is used during assembly.

Reciprocating seals ride on the ridges of the micro-fine grooves while in motion, and thus allow a small amount of leakage. Leakage will increase with the speed of reciprocating motion and with the hardness of the seal material.

Low pressure dynamic sealing (at less than 100 psi especially fuel and pneumatic) is difficult to obtain at temperatures below −40 F with present MIL-P-5315 and MIL-P-5516A materials. The rubber is flexible but has practically no resilience at this temperature and will not exude into the micro-fine grooves.

Friction studies indicate that the longer the delay between strokes, the greater the starting (breakout) friction. British studies indicate that under normal conditions, it takes about 300 hr to reach maximum starting friction. All the friction factors listed in Table I show evidence of the locking or shearing action of the seal in the grooves.

TABLE I—SOME of the FACTORS WHICH MAY BE USED to ADJUST STATIC FRICTION

To Increase Friction	Factor	To Decrease Friction
Increase	Squeeze (Unit Load)	Decrease
Decrease	Surface Finish-Metal	Increase
?	Surface Finish-Rubber	?
Decrease	Groove Length	Increase
Increase	Durometer	Decrease
Increase	O-Ring "W" Dimension	Decrease
Omit	Lubrication	Use
Lower	Temperature	Raise
Stretch	Joule Effect	Compression

NEEDED GLAND DESIGN IMPROVEMENT AND DEVELOPMENT

In order to develop new gland designs and seals for wider temperature ranges, it is first advisable to examine some of the essential characteristics of each element.

Seal material

1. Fluid resistance: At present, the seal manufacturer is forced to spread his development efforts so thin that they are hardly effective. He is now trying to develop fluid resistant materials for eight hydraulic fluids.
2. Coefficient of expansion (unavoidably present though not needed).
3. Flowability of the seal material at all temperatures.
4. Resistance to wear at all temperatures.

Gland Design

1. Lubrication.
2. Spring or pressure loading of seal.
3. Compression rather than tension in the seal material.
4. Breathing.
5. Coefficient of expansion.
6. Metal back-up rings (in addition to organic type).
7. Designs must not exceed elastic limit of the seal material.

Organic Seal Design Factors

1. Surface finish of the seal.
2. Seal shape (to best utilize pressure or spring loading).
3. Seal contact area (against the metal to be sealed).
4. Projected area (to hydraulic action).
5. Extrusion resistance (organic back-up rings, such as teflon).

Only a few of the more difficult factors will be discussed.

Lubrication

Lubrication is the most important requirement. Improper lubrication in the more critical designs causes spiral failure of O-rings. Completely dry (unlubricated) air valve seals have been known to fail after only 680 cycles (Fig. 2), yet these same valves have operated satisfactorily for 10 million cycles when a good grease was applied during assembly. Adequate lubrication cannot be overstressed. The hydraulic engineer or the lubricants chemist must provide it. It cannot be built into organic seal materials.

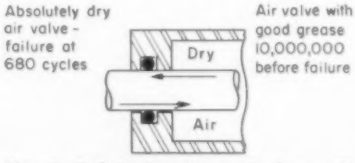


Fig. 2—Lubrication is required on all bearing or rubbing surfaces. A seal is no exception.

MIL-0-5606 evaporates from exposed rods at temperatures above 180 F. Perhaps a high temperature fluid, sealed and pressurized between two seals, is one answer.

Spring Loading

When motion seals must operate above 300 F, spring or pressure loading of seals appears to be the only way to offset compression set, loss of resilience over the temperature range, crystallization, and cold flow.

Even at moderate temperatures, polymers such as neoprene, polyacrylate, thiokol, butyl, and silicone are not recommended for reciprocating or other motion seals without spring loading. Elastomers which are not copolymers have a tendency to crystallize after relatively long inactive periods. Moving units sealed with neoprene O-rings (Fig. 3) may successfully pass laboratory tests for fluid resistance and wear, but when unused for a month or two will leak

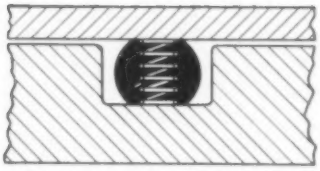


Fig. 3—O-ring acts as a spring.

when retested. This problem has been encountered in air brakes, soft drink dispensing valves, hydraulic systems and others.

Compression set and cold flow becomes more of a problem as the temperature range is increased. It is, therefore, recommended that high temperature seal designs use something other than resilience of the rubber to energize or reset motion seals.

Gland Breathing

Glands should be designed to use the pressure to close the extrusion gap whenever possible. Otherwise higher pressures may break the seal completely. (Fig. 4).

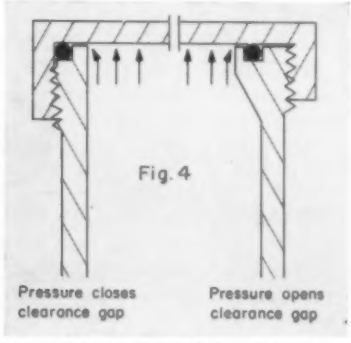


Fig. 4—Groove should be designed so that the enclosed pressure closes rather than opens the clearance gap.

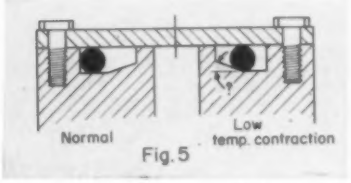


Fig. 5—Proposed groove design would take advantage of the coefficient of contraction to improve the seal at low temperatures.

Coefficient of Expansion

One suggested design (Fig. 5) uses the coefficient of expansion of the rubber (approximately 10 times that of steel) to an advantage. As the O-ring shrinks, it will tend to wedge itself between the two surfaces and effect a better low pressure seal. The principle has not been proven, but looks interesting.

Soft Rubber

A softer rubber seal material (less than 70 durometer) is desirable for the high temperature sealing job. Even though it has less over-all resistance, it usually lasts longer at high temperature and is more flexible at low temperature. With the soft seal, a back-up ring is required to resist extrusion.

Organic Back-Up Rings

Back-up rings should be flexible over the entire temperature range, have sufficient strength to resist extrusion in a high-temperature high-pressure gland, be nonabrasive, adjustable (so as to fit slightly different glands) and compact and easy to assemble on, or in a gland. Its main job is to back-up the seal or plug the clearance gap and thus prevent extrusion. It should not have to seal, lubricate or scrape off contamination.

Single turn bias-cut (22 deg) teflon back-up rings have proven superior to the MIL standard spiral teflon ring. It might well be adopted as an additional standard. New materials such as teflon-coated glass cloth, as well as other high temperature materials are becoming available. The strength of glass fibers is well known, and this coated fabric might be very effective.

Metal Back-Up Rings

Teflon alone is too soft to prevent extrusion at temperatures above 350 F (Fig. 6). Spiral or split metal back-up rings without the teflon tend to cut up O-rings. The combination of metal and teflon back-up rings seems to be the answer. Smaller clearances might eliminate the need for metal back-up rings but this does not seem too economical a solution.

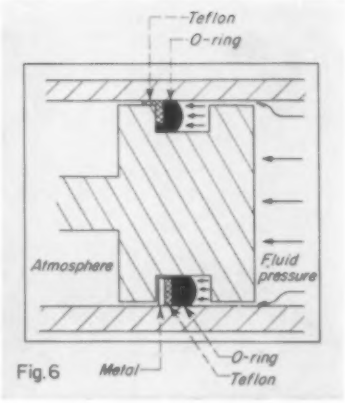


Fig. 6—At high temperatures teflon tends to extrude into the clearance gap. A metal back-up ring in addition to the teflon ring will prevent extrusion.

Elastic Limit of the Rubber

At temperatures above 168 F designs like the AND 10050 boss are less effective (Fig. 7). The chamfer provides a wedge-shaped crevice which must be progressively filled by the O-ring whenever the pressure exceeds 200 or 300 psi. This causes the O-ring to be unseated as well as over stressed. The seal tries to reseat itself on the ID after each pressure cycle. The design asks too much of the material and frequent failures are occurring. An alternate seal (Fig. 8) has been suggested to better fit the cavity and com-

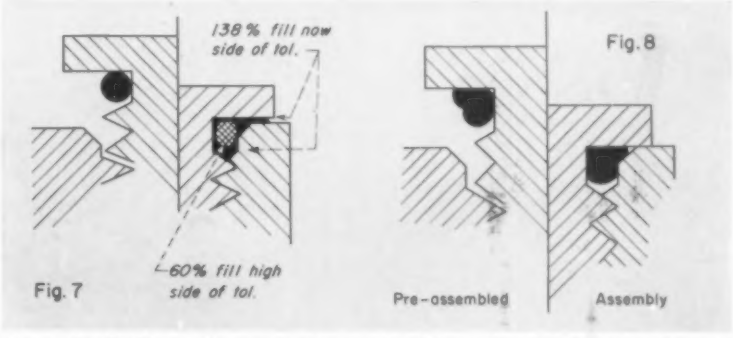


Fig. 7—Standard boss tolerance permits excessive deformation of O-ring when clearance is at low side of tolerence, and insufficient seal compression at high side of tolerence. Fig. 8 shows suggested boss seal to overcome deficiencies in previous designs.

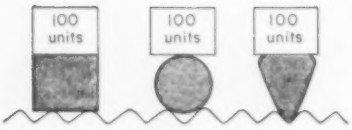


Fig. 9

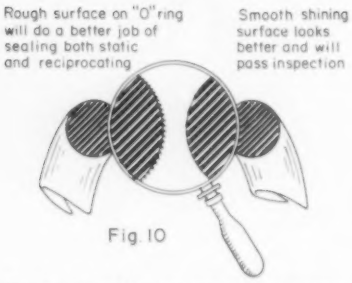

Rough surface on "O" ring will do a better job of sealing both static and reciprocating
Smooth shining surface looks better and will pass inspection

Fig. 10

Fig. 9—A smaller sealing surface permits sealing with lighter loads. The roughened O-ring of Fig. 10 inspires less confidence but is apt to make a better and more reliable seal.

pensate for the poor cavity design.

Below 168 F the problem is overfill or under-fill of the gland, overfill being more critical since the fitting cannot make a metal-to-metal seat.

Surface Finish of Seal

Surface finish for an O-ring seal is a controversial subject. Majority opinion is strongly in favor of the smoothest finish possible on O-rings. However, a controlled rough seal surface finish may be better. A lightly loaded broom (made up of very small sticks) will enter into the cracks of a rough floor and sweep out the dirt; a board will not. A flat gasket or square seal ring as shown in Fig. 9 requires more pressure to make the rubber exude into the micro-fine grooves of the metal and effect a seal. The starting and running friction of a square ring is higher than that of an O-ring under the same conditions.

Among the conclusions reached by the engineers of Cleveland Pneumatic Tool Company in a report dated May 20, 1948, may be found: "A rough finish on O-rings is a definite aid to the stopping of leaks in aircraft landing gear. . . . The finish of 20 (RMS) on O-rings does not stop leakage as well as one of 40 to 100 (RMS)."

The CPT tests also showed leakage extremes. On a test of a running O-ring seal which had been roughened with emory cloth the seal permitted only 0.002 ounces leakage. Under identical conditions a super smooth O-ring lost 0.762 ounces.

Seals with relatively rough surfaces are easier to deform to fit the metal finish. They should reduce leakage, seal better at low and high temperatures, permit a harder seal material to be used, and reduce friction slightly.

Theoretically Optimum Seals

With better seal and gland designs present materials can probably be made to function satisfactorily in reciprocating fluid glands from —65 to 400 F or perhaps 450 F. It may be possible to use standard O-ring glands and seals made from new materials like Kel-F in static applications. At even higher temperatures new and much more complicated seals and gland designs are believed necessary for motion seals.

Some of the seal and gland designs presently in development and test will be described.

A V-O-ring is shown in Fig. 11. Here the attempt has been to combine the advantages of the V-ring with that of an O-ring. When the seal is compressed only the small points will contact the metal surfaces. Twisting and resultant spiral failure should be eliminated because the seal length is approximately twice the width. Friction should be low because of small projected area of the seal to the fluid pressure. Compression requires less force and fluid pressure can deflect the end lips (V's) at very low pressure. Lubrication can be trapped in the V's to help lubricate on the return strokes of an exposed surface. It may be possible to use these seals in present glands and a harder material can be used to prevent extrusion.

In initial test, an O-ring gland was used as a control standard under identical conditions. An industrial accumulator with an 80 psi charge was chosen for the test because this provides a very difficult set of conditions to seal.

After 10,000 cycles, the O-ring gland (low leak design) allowed 11 cc oil leakage which was the lowest ever recorded with this exact setup. The V-O-ring (after 10,000 cycles) allowed no loss of precharge, and not one drop of leakage. Of course, verifying tests and long term high and low temperature tests will be necessary before definite conclusions can be made.

It may be necessary to use grooves with a different shape (Fig. 12) and back-up rings could also be used as expander rings as shown in Fig. 13. The V-O-ring design will lend itself to spring loading as shown in Fig. 14. Note that a C-shaped spring ring is

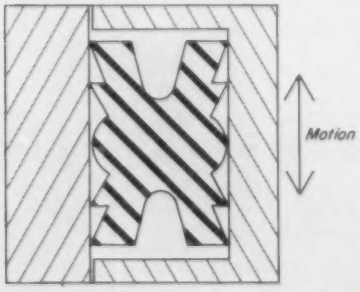


Fig. 11

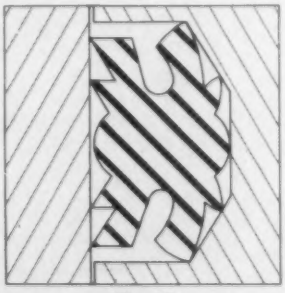


Fig. 12

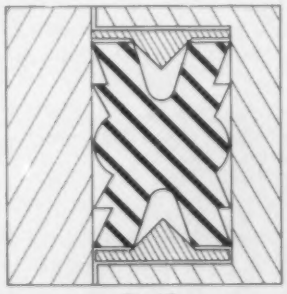


Fig. 13

Fig. 11—A V-O-ring design intended for accumulator and other reciprocating motion seals between — 65 and 325 F. Fig. 12 is an alternate design with some modification of the groove shape. The V-O-ring of Fig. 13 has a teflon back up ring used as an expander.

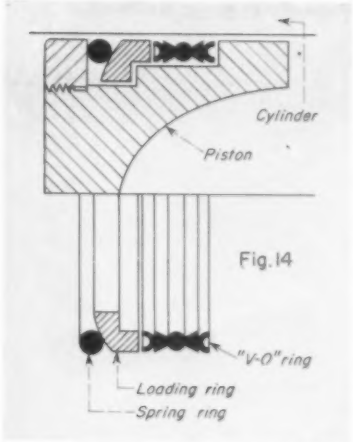


Fig. 14—The spring ring loaded in tension tends to wedge between the loading ring and the V-O-ring to provide effective sealing between —65 and 400 F.

here used to wedge the loading ring. A spring in tension is preferred because it contracts at low temperature. Springs used in compression provide maximum force at higher temperatures where the high loading is least needed and minimum force at low temperatures where it is most needed.

Fluid Type Seals

It may be necessary to adopt a more cumbersome pressure loaded seal (Fig. 15) in order to seal moving glands at

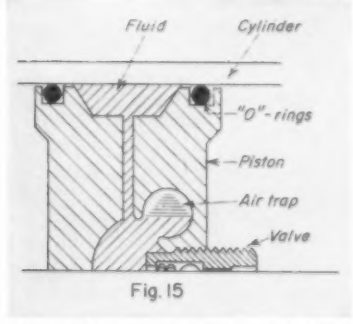


Fig. 15—Here a pair of standard O-ring seals are pressure loaded from an air trap. In this manner the seals are continually lubricated and leakage is minimized.

temperatures of 350 to 500 F. This design should provide the following advantages. Some lubrication is always present regardless of the fluid or gas being sealed in the other part of the assembly. Spring loading of the seals will be provided by the trapped and pressurized expandable gas. Positive sealing is possible because the relatively large liquid molecules of the lubricant are easier to seal than many other fluids. If the proper seal fluid is selected, it should not char as our present hydraulic fluid does. With this type of seal gland, it may be possible to increase the operating range of present fluids. Rod type seals can be kept filled and pressurized from a central source instead of using a gas or pressurizing piston and spring.

Metal Seals for Moving Glands

At the bottom of Fig. 16, a labyrinth seal is shown. Some leakage must be tolerated in this type of seal, but it should be possible to use this seal up to 1000 F. Piston rings can also be used as labyrinth seals and the resulting glands are usually less expensive to produce than the extremely close fits that are necessary for the type shown.

At the top of Fig. 16 is a combination of several types of seals. Spring or pressure loaded metal foil offers the best material and design possibility. It can be spirally wrapped around a mandrel and then compressed into a small ring (while still on the mandrel) with many tiny loops at the top and bottom. Foil rings formed this way are flexible, and the tiny loops present a series of sharp sealing rings or notches to effect a labyrinth seal.

Assuming some leakage will occur, this type of gland can prevent external leakage in several ways. Gas may be blown through the two seals of the gland preventing the fluid from entering. Leakage may be drawn by vacuum from between the seal elements. Fine powder or other similar flowable substance may be used as a seal between the two primary seals. Other types of seals such as asbestos graphite packings also show promise as extremely high temperature seals.

It would be very desirable if one standard high temperature hydraulic fluid were adopted as soon as possible. High temperature seal material and design development will be slow until only one or at most, two hydraulic fluids are to be handled.

EDITOR'S NOTE—Other articles on problems of sealing appearing in *Product Engineering* in recent years which may be of value to the interested reader.

"How to Prevent Oil Seal Failure," by R. O. Isenbarger, January 1953 page 154, discussed reasons and remedies for failure and a check list for proper seal specification was included.

"Synthetic Rubber O-ring Seals," by E. L. Carlotta, June 1951 page 130, described synthetic materials and their application and design for static or moving O-ring seals.

Further "Design Recommendations for O-ring Seals," by J. H. Swartz, September 1951 page 162, offered alternate design sketches and tabulated dimensional data for standard AN or JIC O-rings and gaskets.

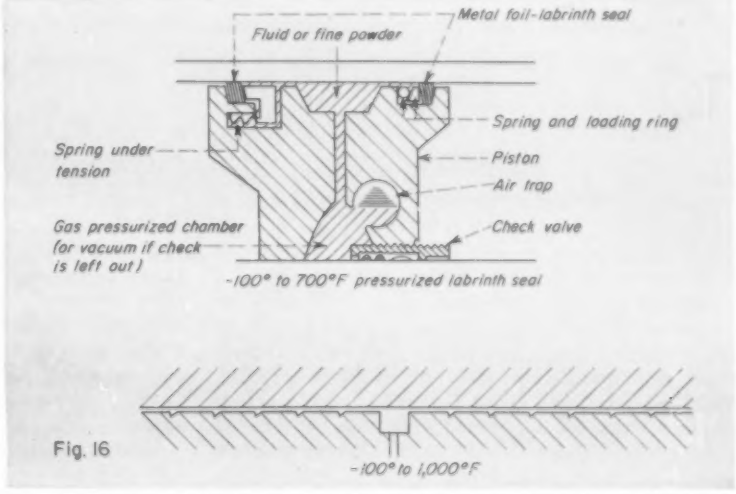


Fig. 16—Bottom, a labyrinth requires close tolerances on the piston and cylinder diameters and will permit some leakage, but is effective in the temperature range of — 100 to 1000 F. Top, a metal foil seal with spring or pressure loading or both. When hydraulic fluids with good lubricating properties are to be sealed the chamber may be kept pressurized, otherwise vacuum pressure can be used to suck the leakage from between the two metal foil seals.

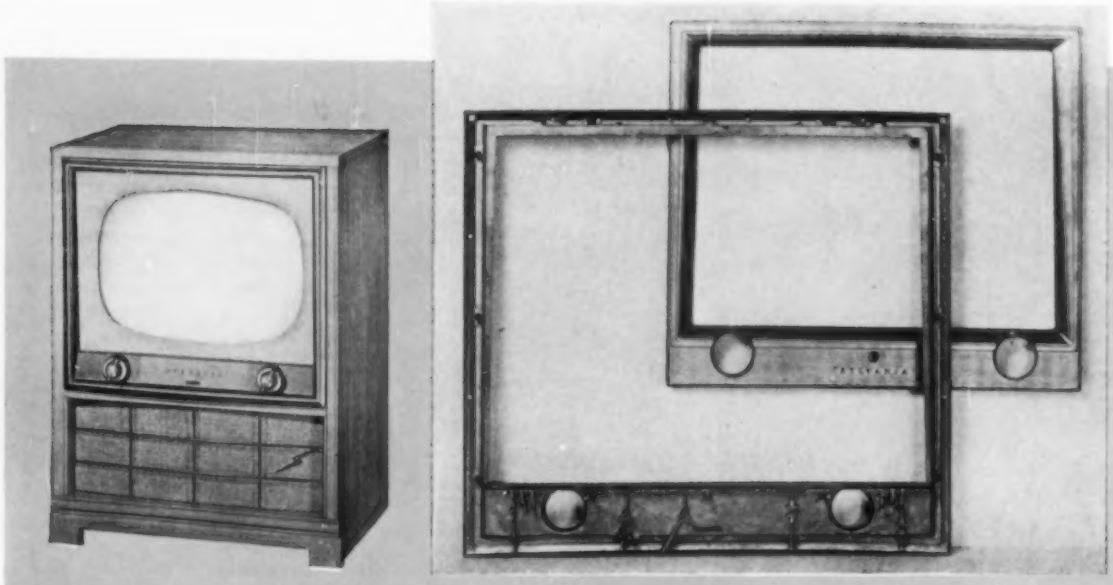


Fig. 1—Bezel for Television Set. Change from stamping to zinc die casting with integral fastening lugs in this Sylvania television receiver eliminated welding operations required to attach fastening units. Die-cast section is tapered and more rigid, and offers more opportunity for decoration. Finish includes a phosphate pretreatment.

Redesign for Die Castings

Design tips on reducing piece costs: integral fastening ideas, use of inserts and rib design to save metal cost; influence of cored holes, fillets, square corners, draft, undercuts; and cost potentials in flatness limitations, blanket tolerances, and surface preparation.

J. J. PUNKE
Vice President, Precision Castings Co., Inc.

WHEN A PART MADE BY ANOTHER PROCESS is redesigned for die casting, the first consideration is the properties of available alloys. Other considerations are: surface finish, and savings in machining costs as compared with die cost; possible savings in material cost and weight through the use of thinner sections, and quantity required, particularly for parts with simple detail.

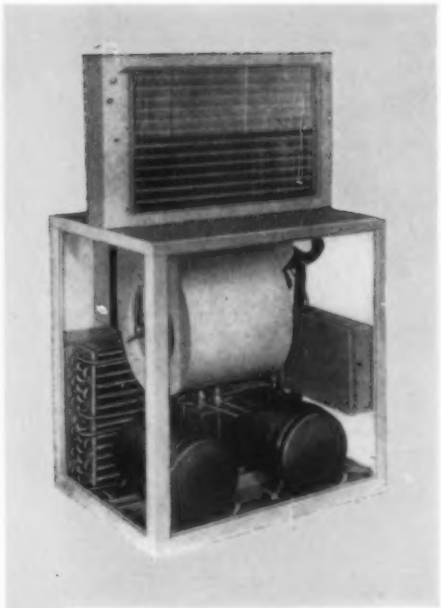
Opportunities for substantial cost reductions in redesigning for die casting are often found in fastening methods, sound use of inserts, reduction in section thickness, addition of fillets on inside corners and radius on outside corners, use of ribs and beads for stiffness with thinner sections. Cored holes, undercuts, drafts and large flat areas within certain limitations also offer cost savings in redesign.

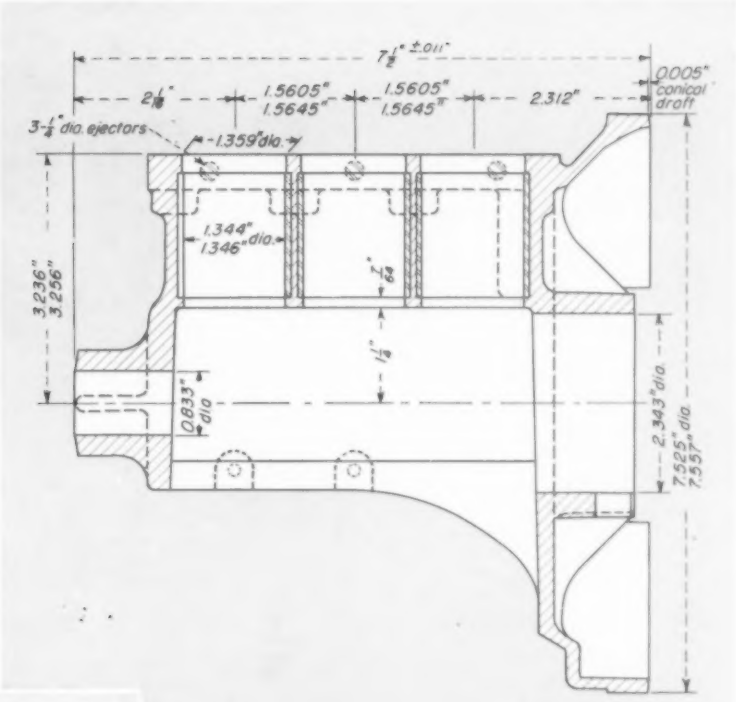
FASTENING METHODS

Integral fastening points often pay off in reducing assembly costs, as in the example shown in Fig. 1. Rivets, studs, lips or lugs may be die cast and staked, headed or spun in zinc or aluminum; zinc with greater ductility offers more opportunity than aluminum. Integral projections can also be designed for speed nuts or spring fasteners, or can be tapped for machine screws or threaded for nuts. Size and shape of integral fastening device can be adapted to the space available, shape of the part and the load applied.

Heading, staking or spinning are most commonly used with zinc, particularly for permanent connections. Spring locking devices with a central barbed hole are not easily removed from a circular stud; where removal is necessary the stud should have a flat slide to permit removal of the spring with a half turn.

Studs of less than $\frac{1}{8}$ in. dia are impractical; design





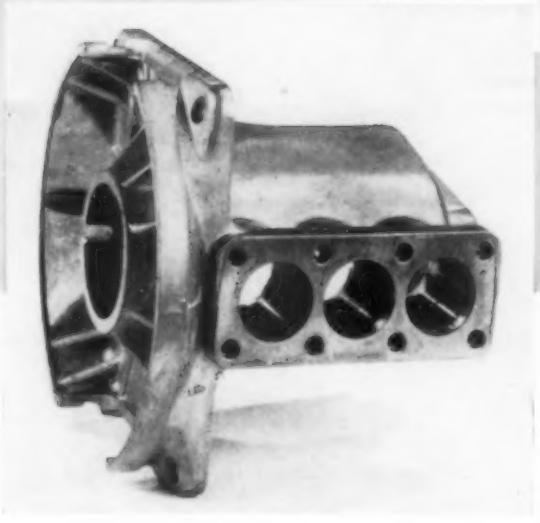


Fig. 2—Refrigerator Compressor Has Steel Cylinder Sleeves Die Cast as Inserts. Residential air conditioner made by York Corporation has two hermetically sealed compressors. Cylinder block is an aluminum die casting with three steel cylinder sleeves cast as inserts. Large end of die casting serves also as end bell and mounting for the direct-connected electric motor.

stresses should not exceed 5000 or 10,000 psi, if bending or vibration is present. For tab fasteners, zinc is preferred for its ductility.

If the fasteners must be stronger than the base metal, steel or brass studs or screws can be cast as inserts with enough metal to provide positive anchorage; or they can be inserted in cored holes. Self-tapping screws may be used.

SOUND USE OF INSERTS

The number of parts often can be reduced, particularly when changing from a stamped assembly, by cast-in or pressed-in inserts. Bushings, bearings, cylinder walls, magnetic cores, or other points may require a material with properties different from the casting alloy. Shrinkage of the cast metal as it cools holds the insert in place; location is determined precisely by the die. But the insert must have a close fit in the die to prevent flash that is often difficult to remove.

Inserts are expensive and should be used only when properties needed cannot be supplied by the cast metal, and when the insert serves to combine two or more parts into an integral structure. Good examples are shown in Fig. 2, a refrigerator compressor with steel cylinder walls, and Fig. 3, a sewing machine base with bronze bearings.

THIN SECTIONS AND RIBS

To reduce metal cost and increase production rate, sections should be made as thin and uniform as rigidity requirements permit. Faster chill for thin sections increases the unit strength and reduces tendency to porosity. Rib design may provide needed rigidity with less metal, and may also aid in flow of metal into die. For bosses subject to concentrated loads, ribs can improve stress distribution.

Shrinkage varies with stock thickness and location of ribs. Where ribs cross or form a checkerboard design, shrinkage may be difficult or impossible to predict accu-

Fig. 3—Sewing Machine Base. Design recently developed by New Process Gear Company has a die-cast base, carefully ribbed to provide needed stiffness with minimum weight. Two powdered bronze bearings are cast in as inserts. Holes in ends, later filled with plugs, clear cores which form holes in bosses to reduce metal required and the cost of removing it by machining.

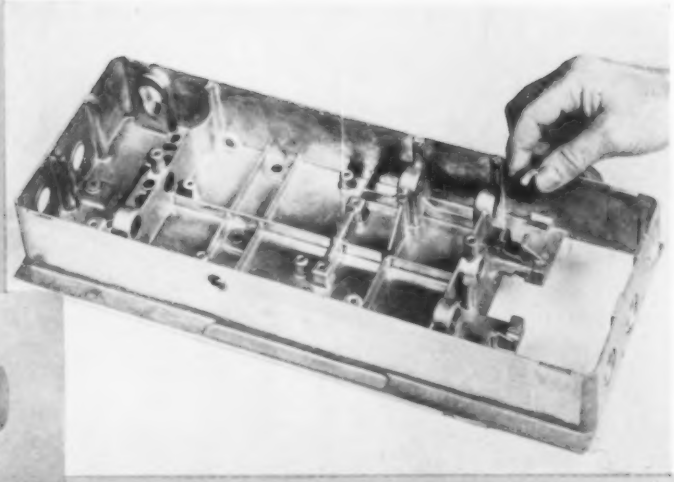
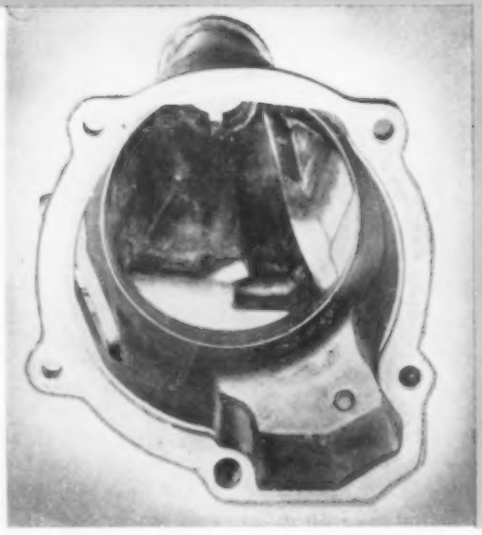


Fig. 4—Automotive Transmission Extension. Redesigned from a gray iron casting to die-cast aluminum, exterior undercuts helped to reduce material cost. New casting weighs only a third as much as the sand casting. Die casting weighs 7.7 lb; wall thickness is 3/16 in.; die has a 20-in. core pull.



rately. Transition between sections of different thickness should be gradual, with adequate fillets and tapers. Coring may be helpful and may also save metal.

FILLETS, CORNERS, DRAFT

For strength and surface smoothness on inside corners, fillets should be a minimum of 0.060 in. A small radius on outside corners helps to reduce die cost and facilitates buffing of castings in preparation for finishing.

Where sharp corners are essential they should be placed where stresses are low. Sharp inside corners may cause the metal to pull away during cooling; sharp outside corners often cause difficulty in die construction. Location of parting line may be an important factor.

Draft allowances depend on shrinkage of metal during cooling and should be generous except where design requirements call for minimum allowances. Particularly on shallow depressions, draft must be sufficient to prevent tearing of the metal in cooling.

CORED HOLES

In redesigning a sand casting, cored holes for a self-tapping screw in the die casting may eliminate drilling and tapping operations. Cores parallel with direction of ejection can be fixed; otherwise, movable die elements must be added at increased cost.

Coring should also be employed to save metal when holes or recesses can be added without undue die cost. Cores of simple shape will minimize tool cost.

Die construction places limitations on diameter and length of core. Only for very short cores can the diameter be less than $\frac{1}{16}$ in. in zinc, or $\frac{1}{8}$ in. for aluminum or magnesium. Maximum length is about four diameters unless the diameter is $\frac{1}{2}$ to 1 in. For holes that cannot be cored, the casting often can be spotted for drill location.

FLATNESS LIMITATIONS

Where good surface finish is important large flat areas should be avoided. A slightly crowned surface or a series of strips or beads will reduce or mask warpage or minor surface irregularities.

If the die casting is bolted to a more rigid assembly, wider tolerances on flatness may be allowable. Larger parts may be made reasonably flat by hand straightening at low cost; later heating as in buffing may restore some of the warping.

UNDERCUTS

In switching from a sand casting it is usually good practice to eliminate undercuts to reduce die costs. However, undercuts on exterior surfaces may save enough metal to more than offset the added die cost. Also, loose pieces may also be used on inside walls.

For example, the automotive transmission housing, Fig. 4, redesigned from a sand casting reduced the weight by two thirds. The unusually long core pull increased the die cast, but the piece cost was less.

BLANKET TOLERANCES

In redesign, blanket tolerances can be a source of needless added cost. Tolerances readily obtainable by machining called for in the earlier fabricating method may result in excessive expense in a die casting. While standard die casting tolerances can often be bettered in normal practice, costs may be reduced by still wider tolerances on unimportant dimensions.

Major factors affecting tolerances are die temperature, metal temperature, location of parting lines, and relative position of slides and cores. Tolerances obtainable may be strongly influenced by the die design; on tolerances that are critical it may be desirable to hold up the specifications until the tooling method is settled.

Another source of unnecessary expense can be a blanket note on burs. For example, such a note might require unnecessary and costly hand removal of harmless flash.

PREPARATION FOR FINISH

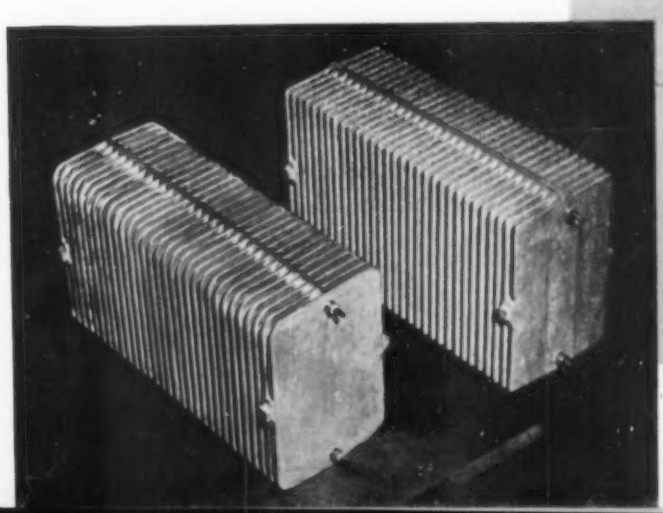
In redesign for die casting, the finish formerly used is often applicable with no more than some minor variation in formulation or application. Zinc alloys can be electroplated; several types of corrosion-inhibiting treatments are available; enamels, paints, lacquers or varnishes can be used. Aluminum castings take mechanical, oxidizing or electroplated finishes; organic paints and lacquers can be applied.

Mechanical finishes on zinc are usually followed by some form of surface protection; on aluminum a mechanical finish alone will often outlast the part. Magnesium castings require a corrosion-inhibiting treatment as a base for organic coatings. All die castings permit baking temperatures usually required for organic finishes. Phosphate pretreatment are often recommended.

EDITOR'S NOTE—A current program on product standards for die casting, conducted by the American Die Casting Institute, includes specification sheets on linear dimension tolerances, parting line and moving die part tolerances, draft requirements for walls, flatness tolerances, depth and draft of cored holes, ejection pin marks and flash removal, and machining allowance; other standards are in preparation. Copies can be secured from the American Die Casting Institute, Inc., 366 Madison Ave., New York 17, N. Y.

For recent articles in *Product Engineering*, see the Annual Handbook issue for 1955, page D-12, "Design Tips for Changing to Die Castings," which includes fifty designs for bosses, cored holes, base plates, base lugs, strengthening ribs and gears. The preceding Handbook issue, page D-20, "Choosing Aluminum Alloy Castings," compares die, sand and permanent mold casting methods and materials, and twelve fundamental considerations to obtain lowest cost. Thorough analysis of all casting methods was also presented in "Evaluation of Casting Processes," March 1954, page 139, in a two-page table covering sand casting, shell molding, plaster casting, permanent mold, investment and die casting.

Two authoritative current texts are sources for detail assistance in designing for die casting. The second edition of "Die Casting," by C. O. Herb, published by Industrial Press, was reviewed in September 1952, page 292. "Die Casting," by H. H. Doehler, published in 1951 by McGraw-Hill, treats basic design.



(ABOVE) Mop wringer bracket and bail ear as previously made by sand casting at left; zinc die castings at right gave lower cost, better accuracy and improved corrosion resistance.

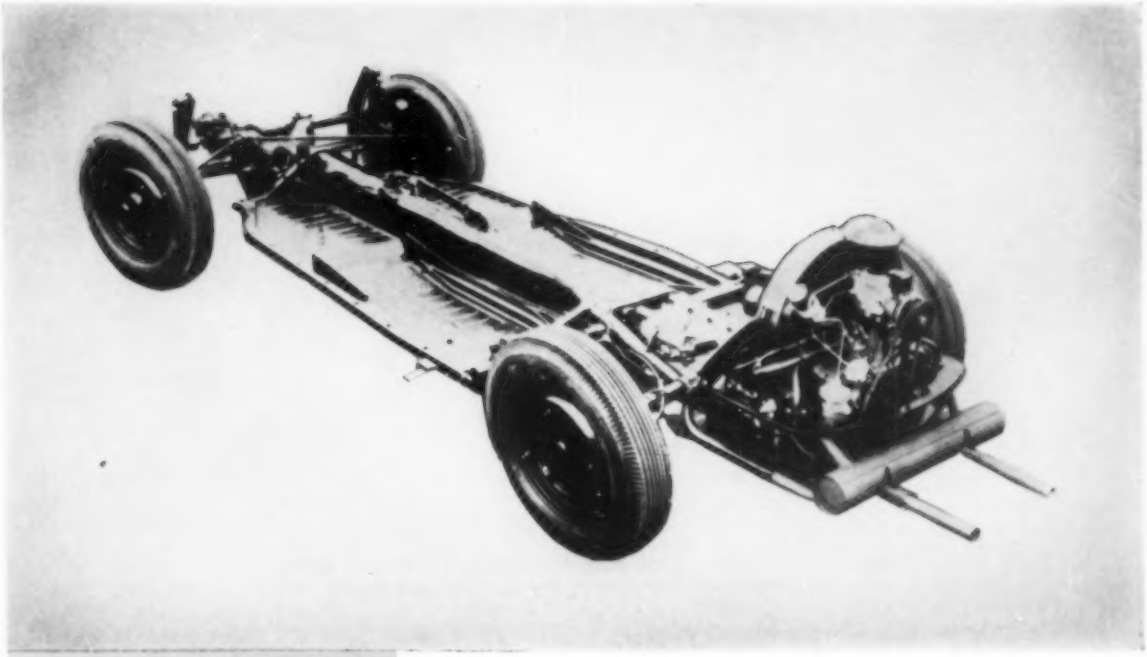
(LEFT) Electrical resistance heater with cast-in heating element: sand casting on right, die casting on left; fin thickness was cut in half reducing weight from 8 to 5 lb.

ORIGINALLY DESIGNED to be the ultimate in low price and economy of operation, the Volkswagen has achieved these aims to a remarkable degree. Light weight and relatively high payload has been incorporated into all models. The passenger car (below) weighs 1600 lb and carries an 850 lb payload. The "Microbus" (left) handles a 1700 lb payload and weighs only 2400 lb while a 2000 lb commercial van will deliver a 2000 lb payload.

Magnesium Castings Contribute to Directional Stability of Volkswagen

Announcement by Volkswagenwerk of Wolfsburg, Germany, that their Volkswagen will be produced in a recently purchased New Jersey plant refocuses attention on this unusual car. Among the unique design techniques contributing to its light weight is the clever utilization of metals throughout the unit. One outstanding example is the use of magnesium castings recently described before the Magnesium Association by Ludwig C. Boehner, Chief Engineer. Proper weight distribution between front and rear axles of a rear engined car is a vital factor in achieving good steering control and directional stability. The application of light metal castings to its heaviest units has given the Volkswagen excellent road handling characteristics.

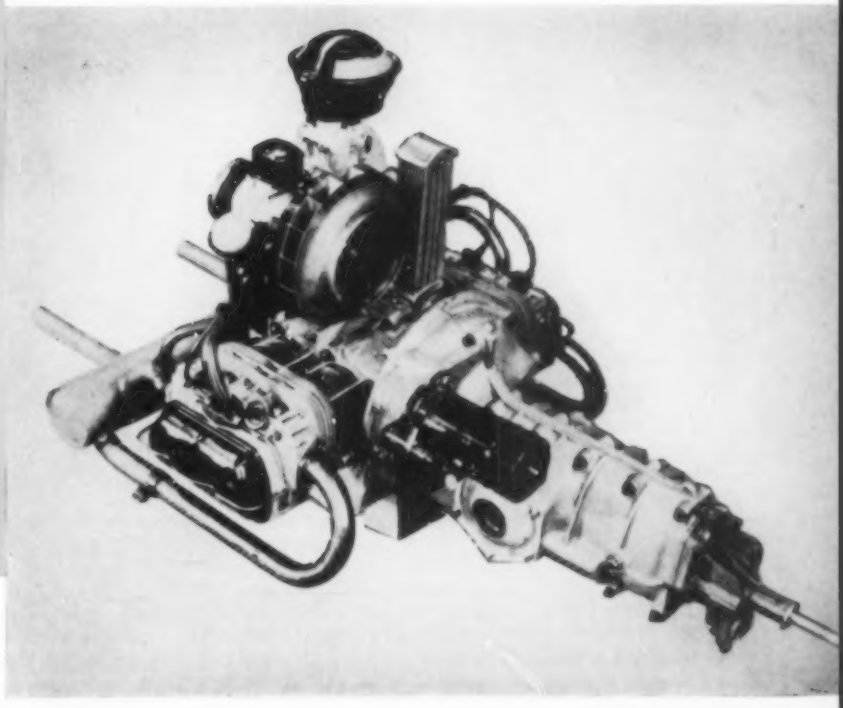
IN NEW PRODUCTS

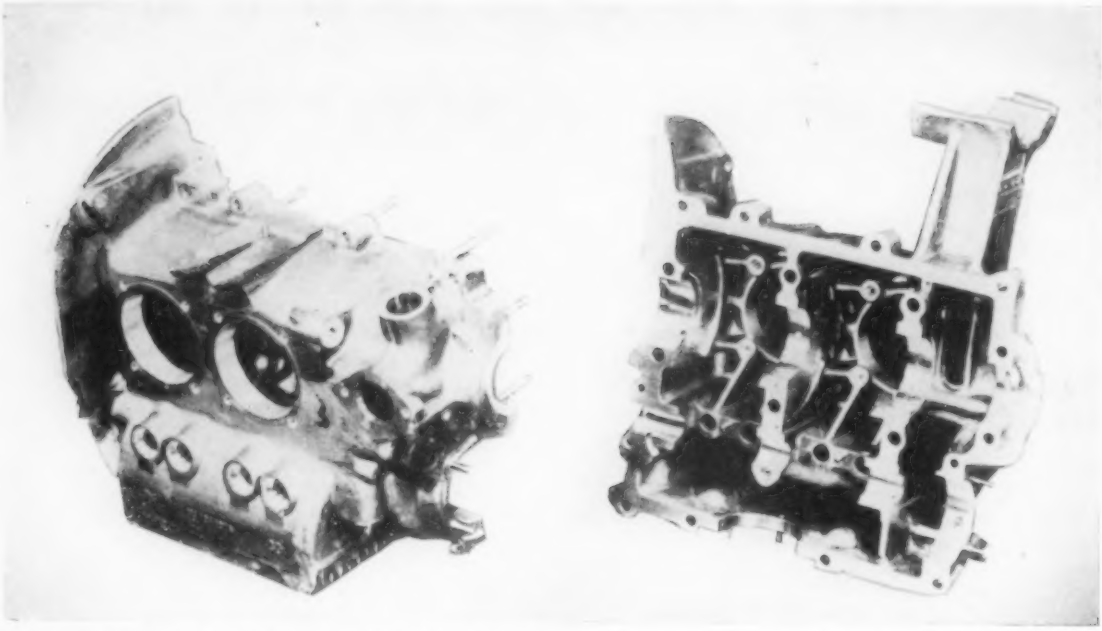


THE 36 HP AIR-COOLED opposed-piston engine is mounted at the rear of the chassis and drives the rear wheels. The heaviest units of the car are the engine, rear axle and the transmission assembly. The overhang of these units at the rear of car necessitated the use of magnesium castings to minimize their effect upon the ratio of weight distribution between the front and rear axles.

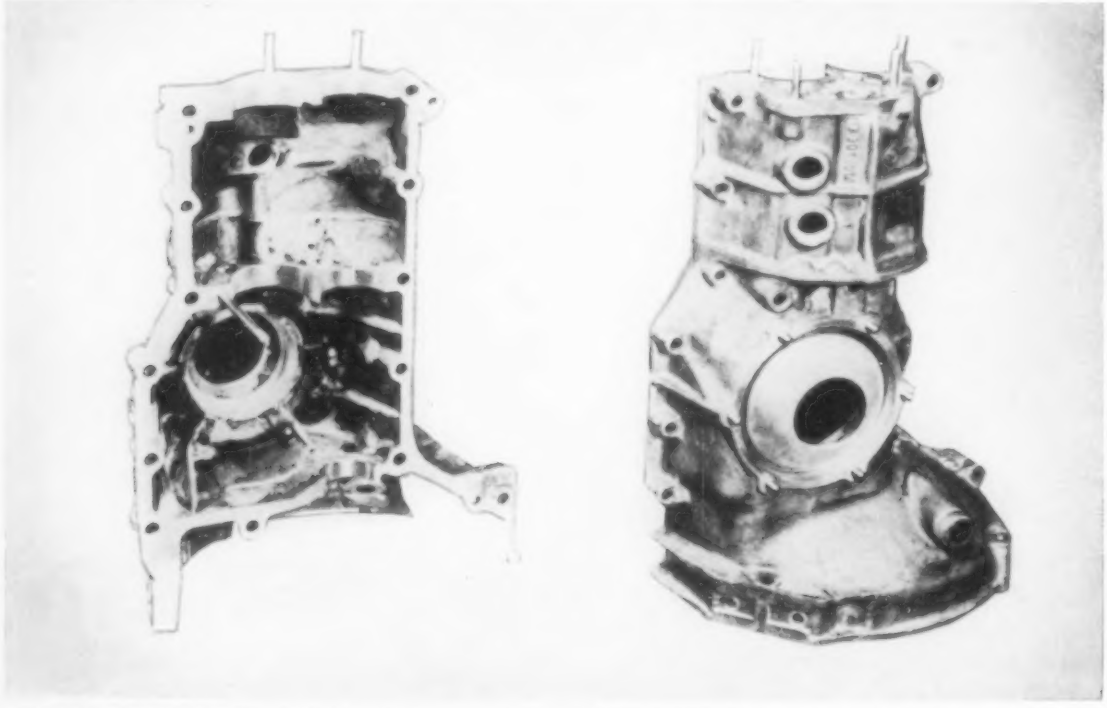
Weight of the unit (shown right) is 270 lb, the engine weighing 170 lb. A total of 36 lb of finished magnesium castings is used in the car. If these magnesium parts had been made of cast iron, an additional weight of 110 lb would have been placed on the rear axle, resulting in an unsatisfactory weight distribution. The Volkswagen car has a 42:58 front to rear weight distribution when loaded with four passengers and luggage.

(continued on next page)

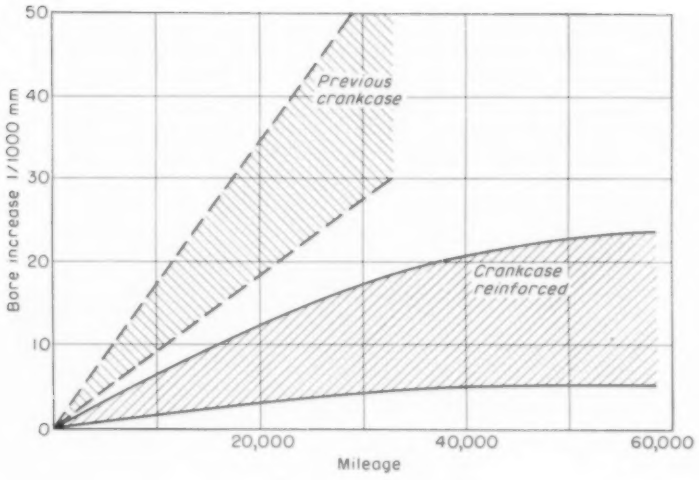




WEIGHT OF THE CRANKCASE CASTING is held to a minimum by using wall thicknesses no greater than those necessary with an equivalent gray iron casting. Although the crankshaft is supported on aluminum sleeve bearings, the camshaft runs directly in the crankcase bore without bushings, possible because of magnesium's excellent bearing qualities.



REAR AXLE AND TRANSMISSION HOUSING encloses a four speed synchromesh transmission and complete differential with swinging half-axles. This assembly is bolted directly to the engine. Magnesium castings are used also for the transmission support bracket, steering gear cover, oil pump housing and camshaft timing gear.



MAGNESIUM'S HIGH COEFFICIENT of thermal expansion and low modulus of elasticity relative to cast iron or aluminum made it difficult to maintain constant engine main bearing clearance and proper meshing of the ring gear and pinion of the rear axle assembly. Bearing clearances must be larger than those used with cast iron or aluminum parts and reinforcement of the crankcase is necessary to control the amount of pounding and subsequent main bearing clearance increase.

Special tooth forms and contours, less sensitive to lengthwise variations have been developed and combined with a correct arrangement of the thrust bearing and a heavily ribbed housing to obtain a quiet and durable transmission and rear axle assembly.

ENGINE CRANKCASE HALVES are cast in permanent molds producing smooth castings practically free of porosity, with a mold life of approximately 120,000 castings before reworking is necessary. The disadvantage is waste metal in the form of deadheads and feeders, amounting to approximately seventy per cent of the final weight. Conversion to pressure die casting is reducing waste metal on raw and finished castings as well as time for molding and machining. Transmission housing and other small parts are now die cast using machines operating on the cold chamber principle which produces about 18 transmission halves per hour.

Castings are machined on special tools of the rotating table or drum type with each casting loaded individually. Use of transfer machines has been avoided as magnesium's 'ow modulus of elasticity permits harmful distortion.

Ease and speed of machining operations and the cleanliness due to absence of a cooling liquid has resulted in very efficient production. Cutting tool life is more than five times that obtained with cast iron while the machining time is less than one-quarter. Magnesium can be machined in about two-thirds the time required for aluminum.

TRANSMISSION HOUSING	PERMANENT MOLD CASTING		DIE CASTING	
	WEIGHT LBS	PIECE TIME MINUTES	WEIGHT LBS	PIECE TIME MINUTES
LEFT HALF CASTING				
WEIGHT INCLUSIVE RISER	16		10.4	
WEIGHT TRIMMED	8.5		7.2	
FOUNDRY TIME		32		21
RIGHT HALF CASTING				
WEIGHT INCLUSIVE RISER	13.9		10.2	
WEIGHT TRIMMED	7.8		6.8	
FOUNDRY TIME		32		20
BOTH HALVES MACHINING AND SCREWING IN STUDS TIME		19		15
TOTAL FOUNDRY AND MACHINE SHOP TIME		83		56

WEIGHT AND PIECE TIME OF DIE AND PERMANENT MOLD CASTINGS

COMPOSITION	
ELEMENT	%
ALUMINUM	7.8 – 8
ZINC	0.1 – 0.8
MANGANESE	0.1 – 0.5
SILICON MAX	0.3
COPPER MAX	0.2
BERYLLIUM	0.0005 – 0.0025
MAGNESIUM	BALANCE

PHYSICAL PROPERTIES	PERMANENT MOLD CASTINGS	DIE CASTINGS
YIELD STRENGTH, PSI	14000 – 18500	17000 – 20000
TENSILE STRENGTH, PSI	20000 – 21500	21500 – 24000
ELONGATION IN 2.5 IN., %	3.25	2
BRINELL HARDNESS (500kg, 10mm)	54 – 56	60 – 64

VW MAGNESIUM ALLOY PROPERTIES

MAGNESIUM ALLOY used is similar to SAE 501A with the properties indicated. A small amount of beryllium is added to the metal to prevent oxidation, improving foundry working conditions by consequent reduction of sulphur dioxide fumes.

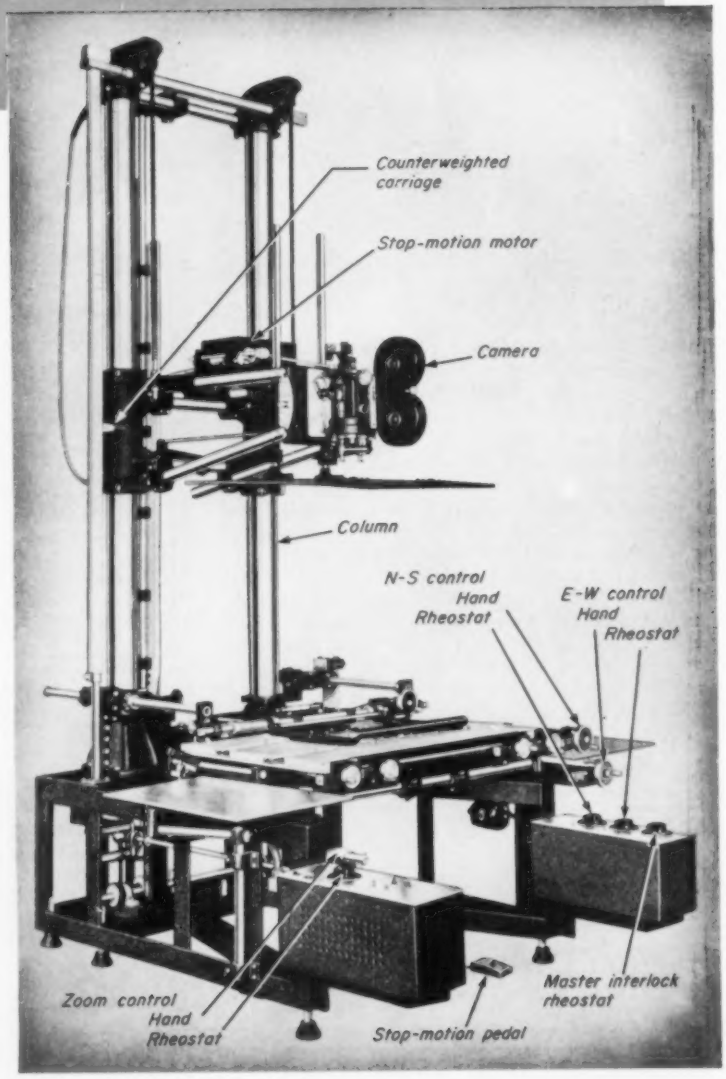
Gradual cooling of castings between single machining operations is necessary to prevent distortion and undue expansion, as no cooling liquid can be applied and it is essential that the temperature of the casting be held low enough and rather constant during the machining operation. Direct rays of the sun are avoided and the shop temperature is maintained low and constant.

Every effort is made to keep the danger of magnesium fires to an absolute minimum. It is important that chips are not too fine and are removed quickly from the work piece. Cutting tools must be kept sharp with large rake angle and small cutting angle and the cutting speed must be limited, for example, to about 650 ft per min on precision boring. When small local fires occur, gray iron chips are used as an extinguisher. The fine magnesium dust which develops during machining must be removed for the health of workmen.

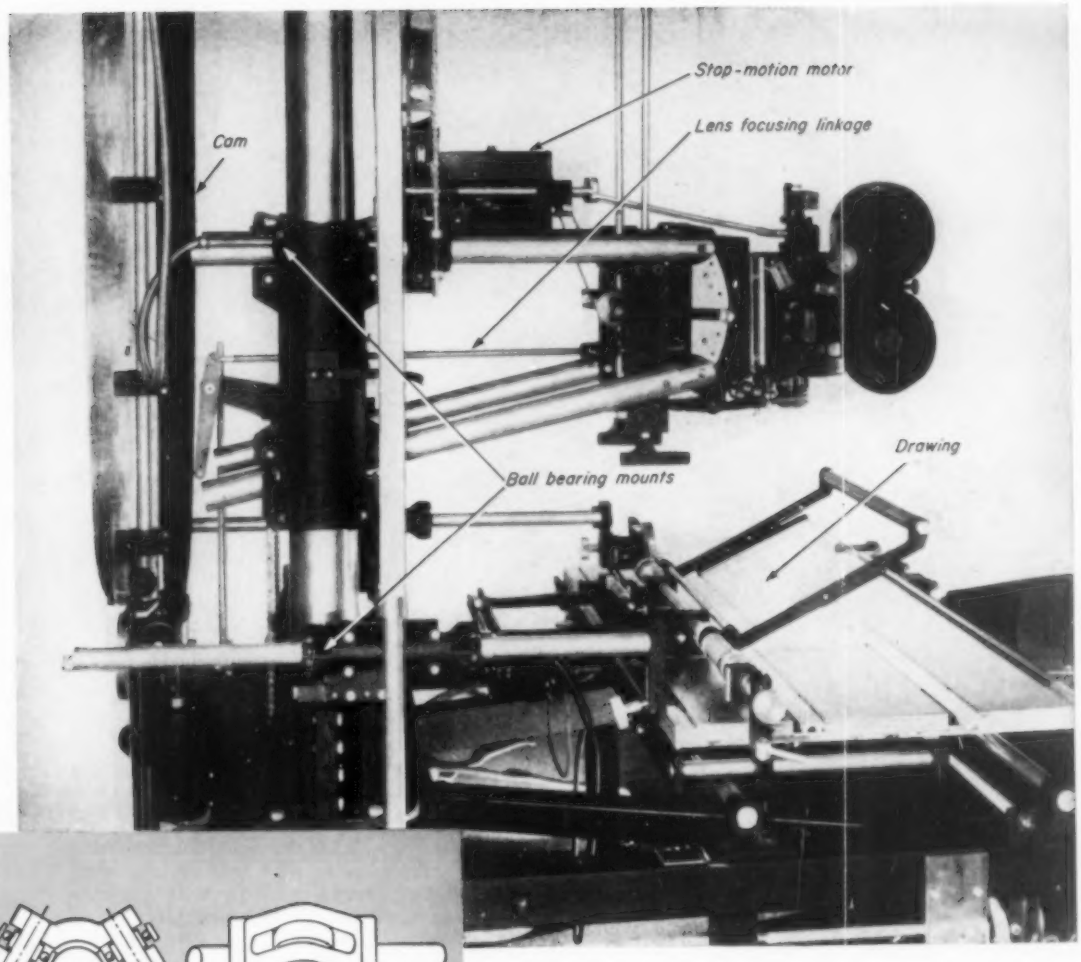
Low-Friction, No-Play Mechanisms Maintain Precision in Camera Stand

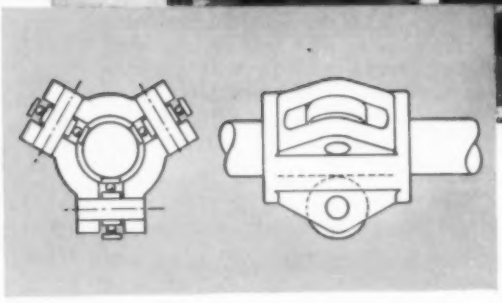
Conventional methods of producing animated films require hundreds, if not thousands of pieces of artwork. Each movement is divided into a number of stages determined by the camera speed and a drawing is usually made for each stage. This is expensive and time consuming; too much so for many potential users of animation for sales promotion, advertising, educational and training films.

With these specific markets in mind, the Animation Equipment Corp., of New Rochelle, N. Y., has evolved a new approach to the problem. Often they found it is not necessary to have the individual characters move. Rather it is possible to duplicate many actions by mounting a drawing on a table and moving the table with respect to the camera. Refinements can be introduced by driving one part of a drawing with respect to another. For example, a scenery background can be moved across the path of the camera to give the effect of a person or automobile in motion. The result is that a film can be produced with only a small fraction of the drawings otherwise required, in a much shorter time and with considerable savings in cost.



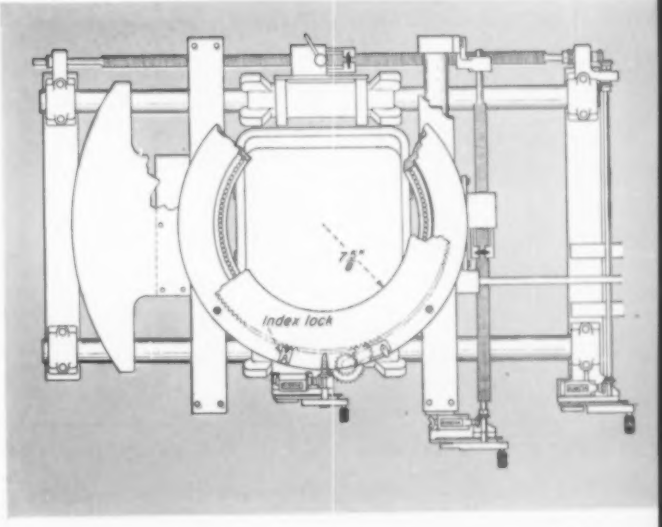
TO GENERATE COMPOUND MOTIONS and produce special effects, camera carriage can be raised or lowered at different speeds; table can rotate and simultaneously move in east-west and north-south directions. Table travel can be controlled by handwheels or the two speed components set on rheostats as shown and the motion automatically controlled from a master interlock rheostat. A conventional closed-loop, tachometer feedback servo system maintains precise speed control for each component of table movement.



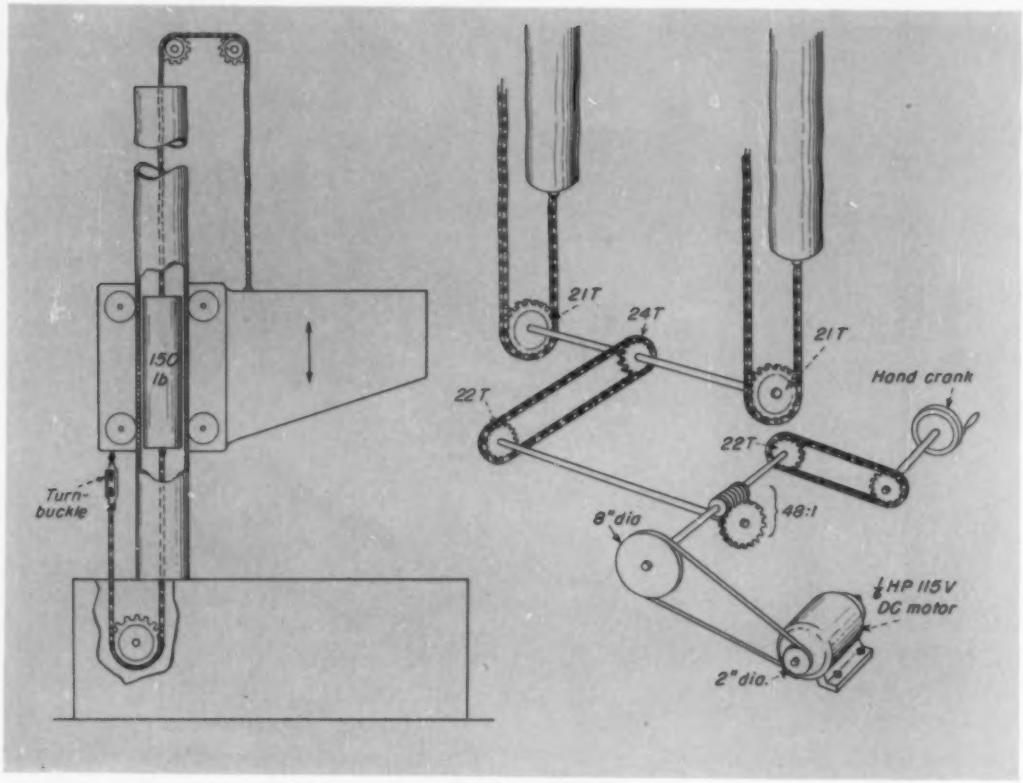


(continued on next page)

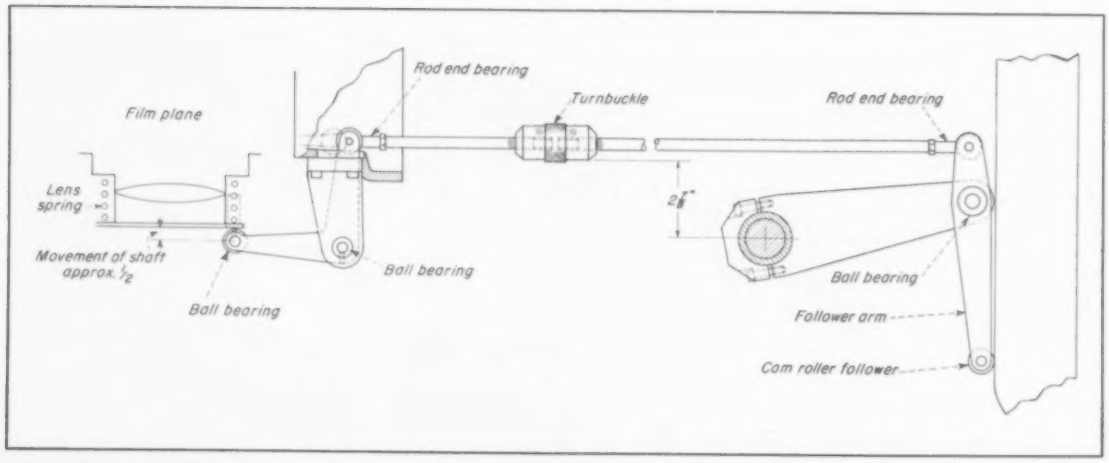
(ABOVE) Static as well as dynamic friction in camera carriage and table mounts must be rigidly controlled to maintain precise registration of position and speed of camera and drawing. Bearing assemblies consist of three equally spaced ball bearings that roll on centerless ground tubes (see inset). Bearings are mounted on eccentrically ground pins with screw driver slots at one end for easy adjustment to compensate for wear.



(RIGHT) Spring-loaded split nuts compensate for back lash on lead screws used to drive table in east-west and north-south directions for a no-play mechanism. Ball ring minimizes friction for rotation which is manually controlled. Drive is conventional worm gear unit through a counter so calibrated that one revolution of handcrank equals one degree of table rotation.



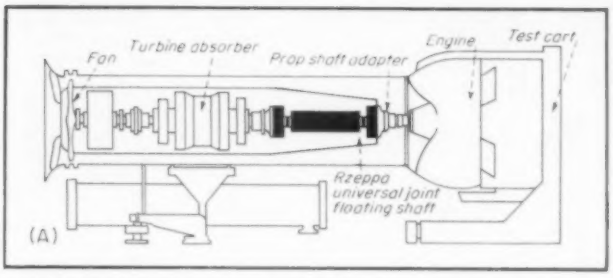
MOTION OF 450 LB CAMERA CARRIAGE must be smooth, free and accurately controlled. Two 150 lb counterweights inside the vertical columns permit the carriage to move easily, and an endless roller chain drive gives positive control of its position and speed. Veeder Root counter driven directly from chain serves as height indicator. For manual operation, one revolution of handwheel equals ¼ in. of camera travel. Power drive requires only a ½ hp motor with a 200:1 reduction.



NO-PLAY MECHANISM for automatic camera focusing. Lens mount moves vertically instead of rotating as in conventional equipment to maintain optical center that varies from mechanical center. Lens position is controlled by ball bearing cam follower riding on face of vertical plate cam which is precision cut to match each lens. Lens spring compensates for wear in all pivot points and assures positive cam contact at all times. Turnbuckle is used to remove initial play in the mechanism.

Constant Velocity Universal Joint Permits Packaged Test Facility

Special universal joint built by Rzeppa Joint Division of Gear Grinding Machine Co., Detroit, Mich., eliminates alignment problems for Clayton Mfg. Co., El Monte, Calif. in connecting aircraft engines to dynamometer of propellerless test facility.



MAJOR PROBLEM in developing first packaged, propellerless aircraft engine testing facility (A) was requirement for large universal joint to transmit motion uniformly between engine and dynamometer.

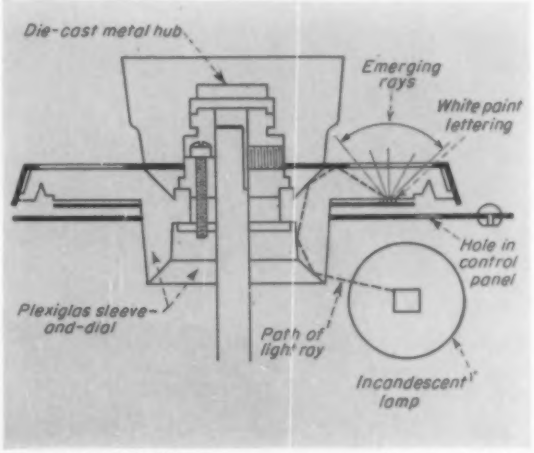
FLOATING SHAFT COUPLING (B) utilizes two constant velocity, disc type universal joints to transmit 5000 hp at 1200 rpm. Joint's neoprene seal allows 18 deg working angle. Coupling's low inertia, constant-velocity design eliminates radial forces, permitting testing of engines on flight mounts with a test facility of simple design, low maintenance and 10,000 hour life.

Plexiglas Used to Illuminate Washer Control Dial

Light transmitting characteristics of the acrylic plastic Plexiglas are used advantageously by designers of the latest Easy automatic washer. A uniformly lighted control dial has been produced which is illuminated by a small, concealed lamp.

DIAL IS MADE of a disc and a heavy sleeve molded in one piece of clear Plexiglas molding powder, a product of Rohm & Haas Co. Hub is metal die casting and dial is backed up by a snugly fitting metal plate. A metal rim completes the assembly. Dial is lighted by a lamp concealed behind control panel. Light enters sleeve through outer wall and is reflected upward by 45 deg bevelled edge. Second bevel at top surface reflects rays radially throughout entire dial face.

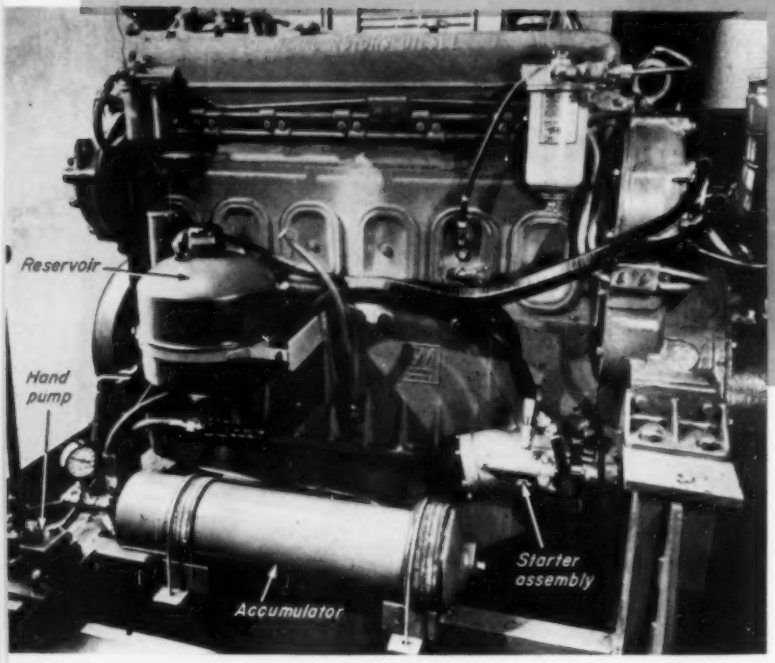
Legend is painted in white on second or interior surface of clear molding. Contact of painted letters with Plexiglas surface interrupts air-Plexiglas interface causing letters to reflect light passing through face of dial, illuminating all control markings simultaneously. Dark red background is furnished by painted metal plate



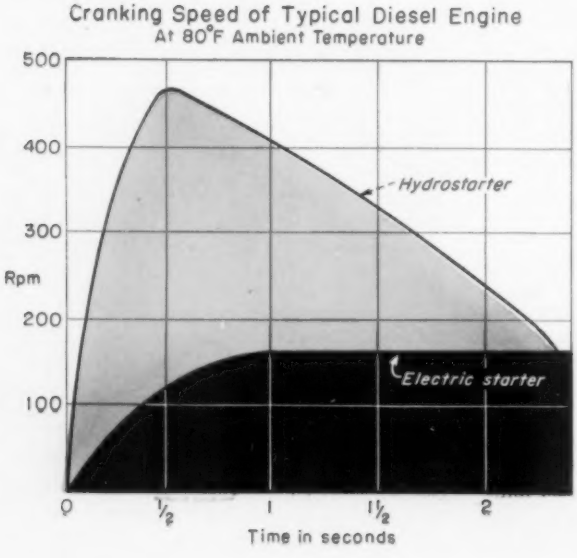
mounted behind dial so as to preserve air-Plexiglas interface. Small hole in control panel above lamp throws a spot of light on red grooved ring as a pointer.

Hydraulic Unit Starts Engines Faster Over Wider Temperature Range

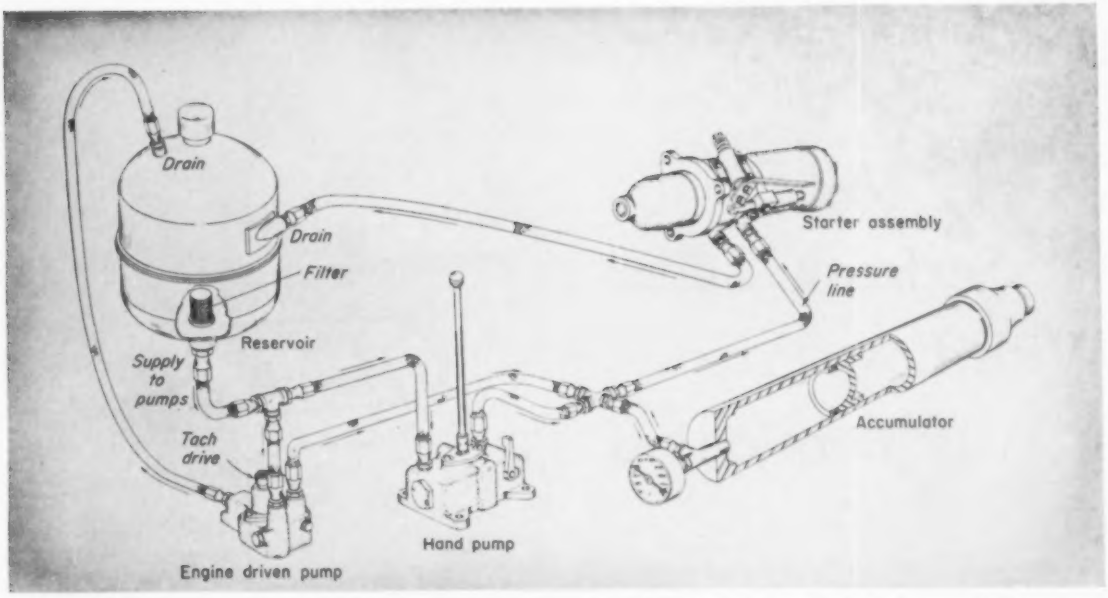
A hydraulic starting system for cranking internal combustion engines has been designed by Aeroproducts Operations, Allison Division of General Motors, Dayton, Ohio. This system called the Hydrostarter develops higher torque and more rapid acceleration than the conventional electric starter and operates satisfactorily down to –40 deg F.



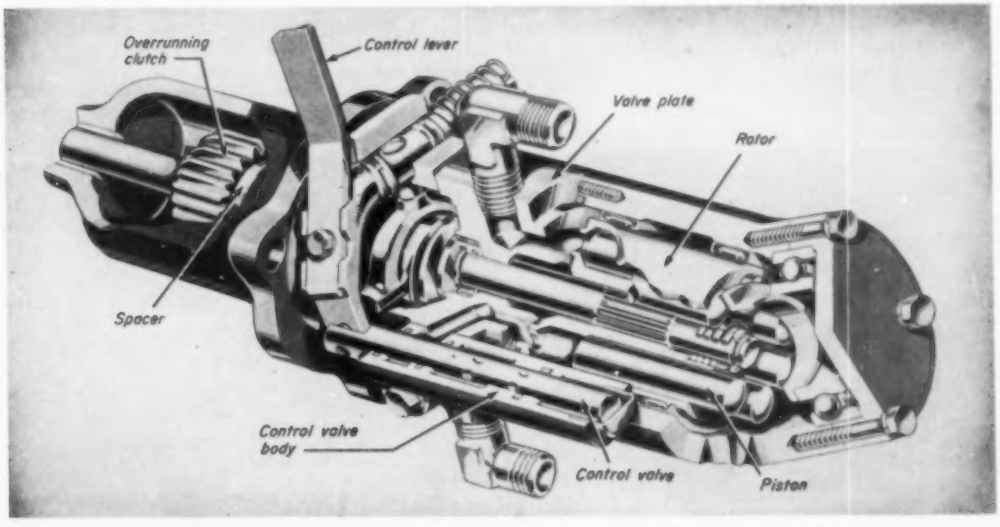
HYDRAULIC STARTER mounted on diesel engine. System requires less space, weighs less than other starting systems, needs no outside energy source and is safe from fire and explosion hazards. The hydraulic motor mounts on the flywheel housing in the same way as an electric starter. The unit operates at 3000 psi, producing a locked torque of approximately 80 ft-lb. The hydraulic motor has given more than 70,000 starts without excessive wear. Minimum design mechanical life of the system is about 10,000 engine hours.



AS SHOWN IN GRAPH, the hydraulic starter cranked a diesel engine to more than three times the speed in the first half second. The same engine at 20 deg F, peaked at 290 rpm in 0.4 sec; at zero deg F the engine peaked at 200 rpm in 0.4 sec. A mixture of 75 per cent diesel fuel and 25 per cent SAE 10 or 30 motor oil has the required high viscosity index and desired lubrication characteristics; this fluid also meets the added requirements of low cost and ready availability in the field.



THE HYDRAULIC MOTOR operates from pressure stored in the accumulator which is charged by the single piston, single acting engine driven pump. A single piston, double acting hand pump is used to initially charge the system and for emergency recharging. When the accumulator is fully charged, the engine-driven pump discharges to the reservoir at lower pressure. The reservoir, in addition to serving as the pump sump, reduces velocity of the recirculated fluid. A breather and strainer are incorporated into the reservoir.

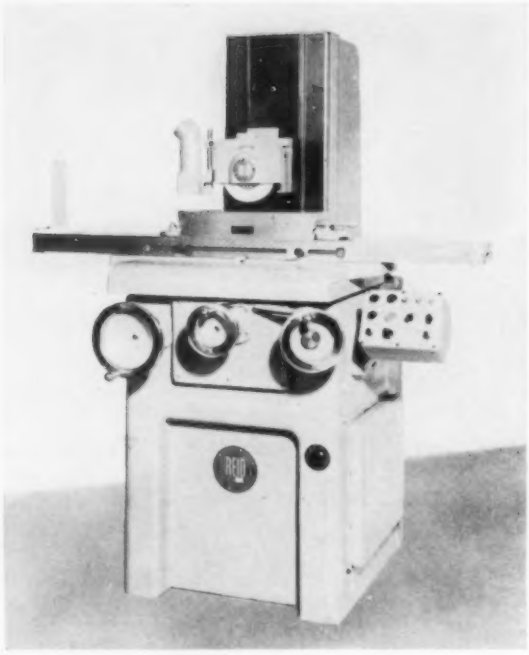


THE PISTON-TYPE HYDRAULIC MOTOR required several design modifications to allow for the fluid surge on opening of the control valve. A spacer has been placed next to the clutch pinion and a bleeder hole placed in the control valve piston; this insures that the control lever engages the pinion with the flywheel ring gear without tooth damage. The control lever actuates the control valve piston and overrunning drive clutch simultaneously. The spacer permits the pinion and ring gear to engage before the main flow ports of the control valve piston are opened, the bleeder restricting the fluid flow until the two gears are in complete mesh.

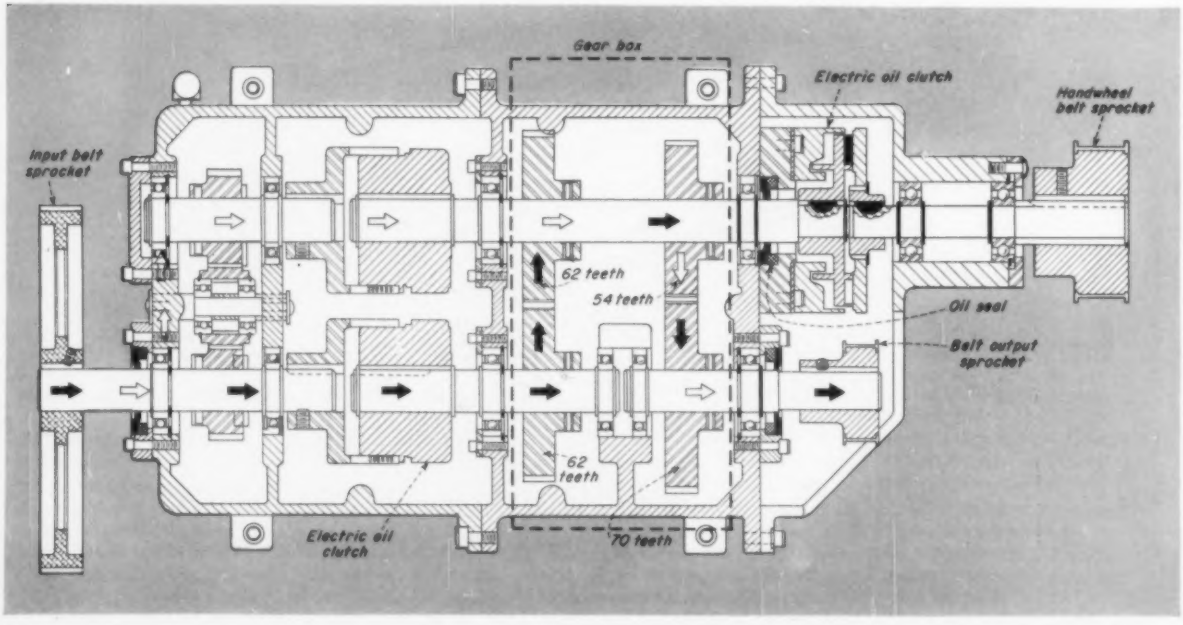
During field tests, the rush of the high velocity oil at the start of the cranking cycle tended to cut the O-ring seals in the control valve. Two sets of six holes were placed around the piston wall periphery, one set on each side of the seals placed in the valve body. The fluid now travels in one set of holes, through the hollow piston and out of the second set of holes to the starter motor, isolating the seals. Four of the holes are visible in illustration above.

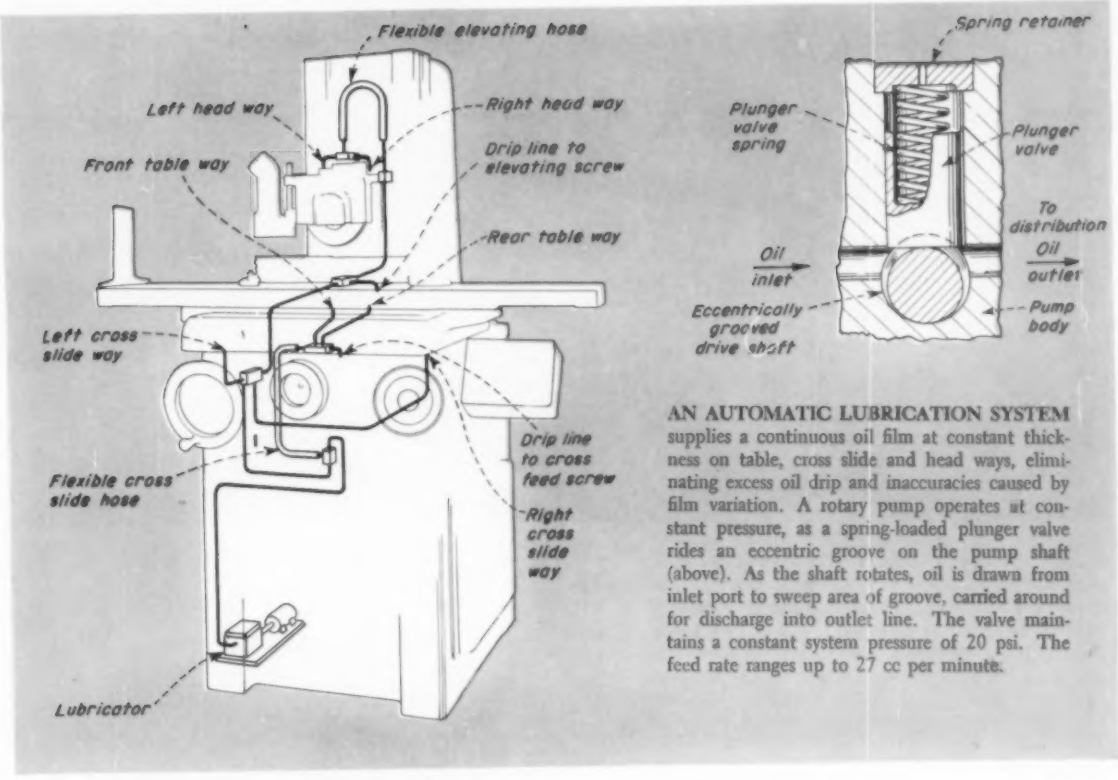
All-Electric Surface Grinder With Low Pressure Way Lubrication

All-electric drive and control has been designed into the Model 824 Surface Grinder manufactured by Reid Bros. Co., Inc., Beverly, Mass. Infinitely variable table traverse has been obtained together with equally flexible cross feed. The grinder incorporates a new low pressure lubricating system and rotary pump developed by Bijur Lubricating Corp., Rochelle Park, N. J., for a constant oil film on the machine ways. Design of the grinder was under the supervision of Walter Fergnani, Vice President, Reid Bros. Company.



DRIVES AND CONTROLS are easily accessible—motor spindle unit and drive motors are serviced from rear of grinder, lubrication unit from left side and electrical panel from right (dust-clean) side. Complete control array (except table speed dial) is mounted on one plug-connected station. Cross slide and table V-ways are inverted to help protect against dust. Grinder weighs 1200 lb more than previous model, most of added weight distributed through the arm and arm support castings.



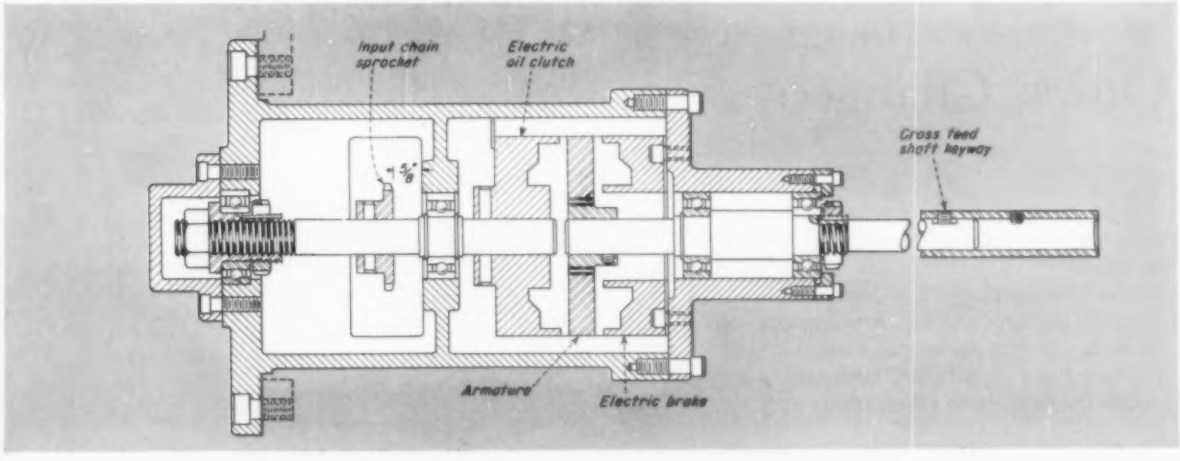


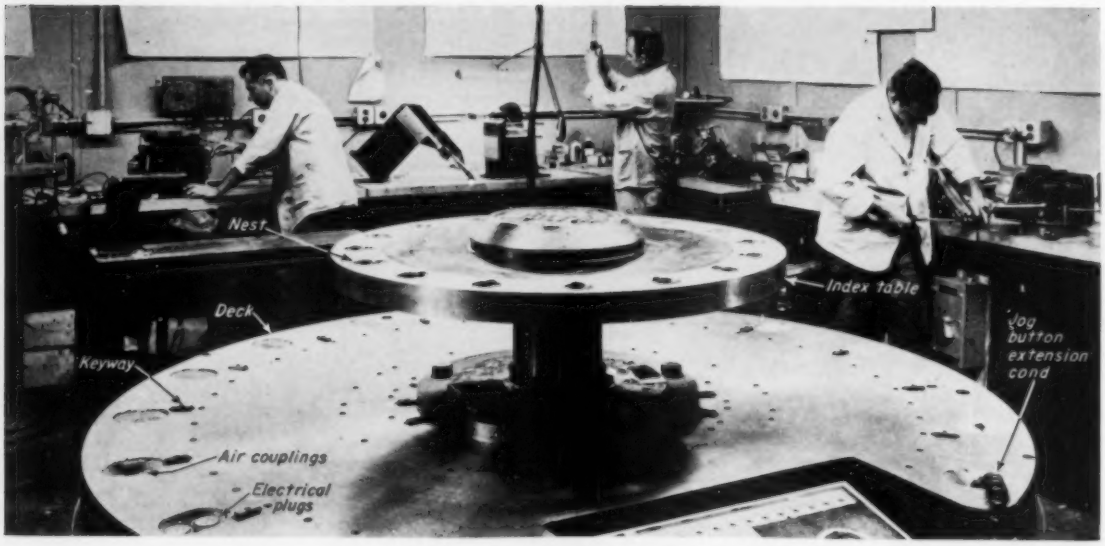
AN AUTOMATIC LUBRICATION SYSTEM supplies a continuous oil film at constant thickness on table, cross slide and head ways, eliminating excess oil drip and inaccuracies caused by film variation. A rotary pump operates at constant pressure, as a spring-loaded plunger valve rides an eccentric groove on the pump shaft (above). As the shaft rotates, oil is drawn from inlet port to sweep area of groove, carried around for discharge into outlet line. The valve maintains a constant system pressure of 20 psi. The feed rate ranges up to 27 cc per minute.

TABLE TRAVERSE is powered by a variable speed d-c motor which alternately belt-drives two oil-cloth shafts (lower left). At end of each traverse, a reversing switch de-energizes one clutch, energizing the other. The output sprocket belt drives the reversing shaft. A rheostat on each clutch is used to adjust the reversal torque. Table can be fed manually by de-energizing these two clutches and energizing the hand feed clutch.

Cross feed is obtained by a constant speed a-c motor continuously driving an electric oil clutch (lower right). An armature keyed to the cross feed shaft engages the clutch or electric brake, which are alternately energized by a rheostat-adjusted electronic timer (not shown). Cross feed increments can be adjusted down to 0.0005 in. The cross feed motor also powers the elevating head, chain driving a clutch shaft geared to the elevating handwheel shaft.

All belts used are Gilmer timing belts which are oil protected by a nylon fabric.

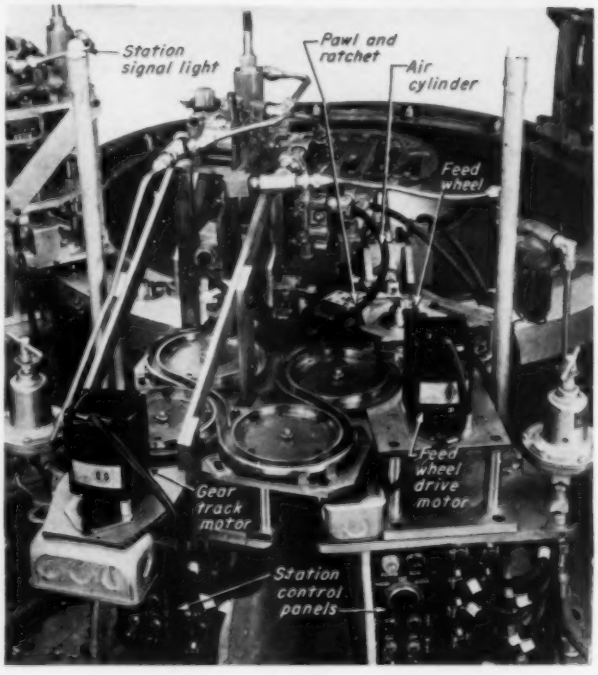




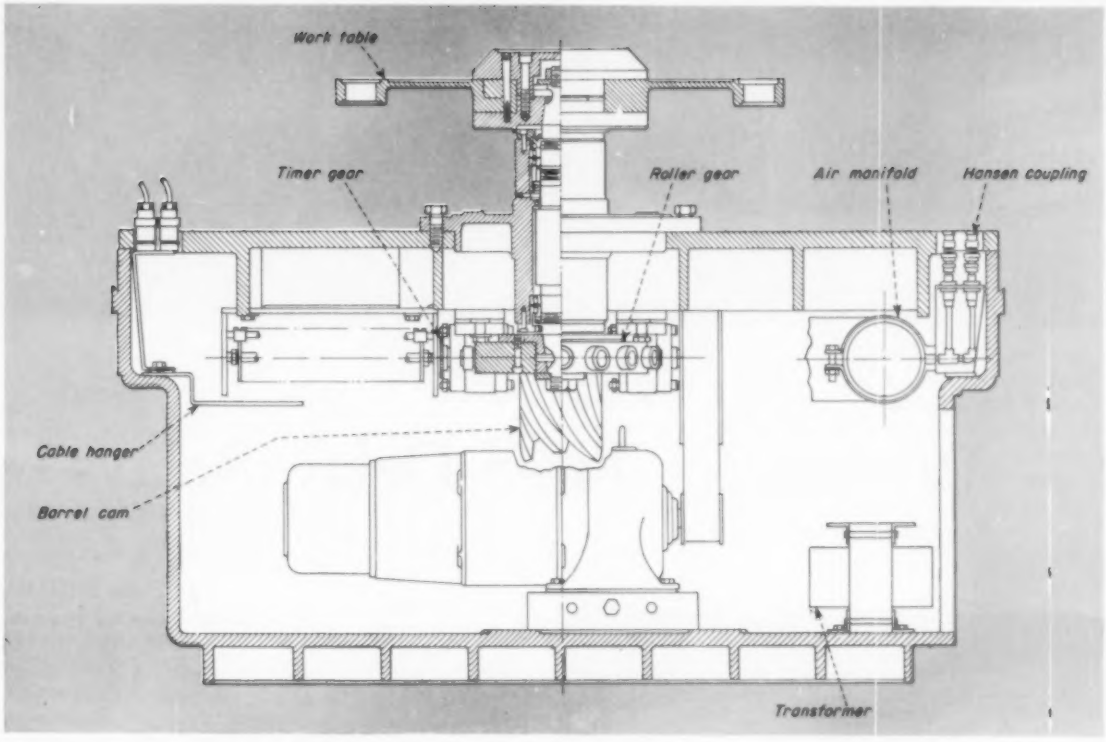
BASIC ASSEMBLY MACHINE. Keyways on deck align tool holder plates to 0.005 in. accuracy. Wells contain alternate pairs of power plugs and air couplings; air manifold is inside outer edge of deck. Parts-feed units are bracketed to side of deck. Base of machine is cast nickel iron with five doors spaced around periphery for access to drive and controls; outer deck is ribbed cast nickel iron. Lights on control panel indicate respective station malfunction. Portable jog button is to right of the programming panel.

Assembly Machine Engineered for Quick Changeover

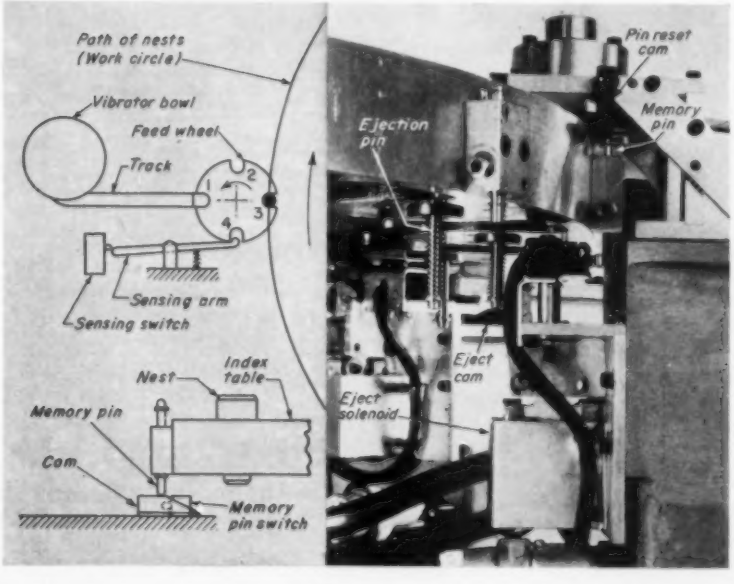
A 16-station assembly machine that can be completely re-tooled in a few hours has been developed by the Multra Corp. (subsidiary of Barnes Engineering Co.), Stamford, Conn. Tools are mounted on plates keyed and screwed to deck, electric power and control is plug-connected and air is tapped from manifold by means of quick-connect couplings.



ONE ASSEMBLY OPERATION required that a sub-assembly be filled with liquid; a time delay before the filled part reached the next station was necessary for full absorption of the liquid. The part is mechanically transferred from the index table onto an intermittently driven feed wheel. A continuously running motor drives this wheel through a spring clutch, the air cylinder actuating an arm that alternately locks and unlocks the clutch through a pawl and ratchet. The four motor-driven gear wheels convey the part for ultimate transfer to an insertion tool which returns the part to the indexing table. The two control panels shown allow for manual or automatic operation of the station.



FERGUSON TABLE INDEXER gives high dwell to index time ratio (about 3 to 1). A barrel cam is belt driven by a variable speed d-c gear motor; the cam through a worm and gear action roller-indexes the table spindle. The cam is shaped to smoothly accelerate and decelerate the table between stations. During each dwell, the cam wedges between two rollers, pre-loading the roller ball bearings to maintain a fixed table position. A modified cam-type timer driven from the barrel cam shaft is used in programming the tool operation.



MEMORY PIN SYSTEM signals stations that part feed has been interrupted at a preceding station. If part is not fed by hopper into feed wheel, as in slot 4, shown (upper left), a sensing arm enters the slot disengaging the sensing switch. A solenoid is de-energized causing a spring-loaded cam to move towards the index table (lower left); as the machine indexes, this cam pushes up the memory pin of the nest scheduled to receive the part from slot 4. The pin at this nest now fails to actuate the memory pin switch at this and succeeding stations; thus, no parts are added to an established incomplete assembly. At reject station (right), the memory pin in up position again fails to actuate the pin switch. The ejector cam through solenoid control is moved into position as shown, raising the ejector pin to deposit bad assembly into reject wheel. Memory pin is returned to down position by reset cam on index to next station.

Pneumatic Time-Delay Relays

CARL LINDAHL

Chief Engineer, Research and Development
A'G'A Division, Elastic Stop Nut Corp. of America

FOR TIME-DELAY CONTROL APPLICATIONS where a time delay must re-cycle when interrupted; where the time delay must be initiated and carried out when control power is interrupted; where time delays are required when control power is both applied and disconnected; or where the required time delay may range from a fraction of a second to 15 minutes, pneumatic time-delay relays, shown in Fig. 1, find wide use.

These relays are actuated by a solenoid plunger which operates contacts mechanically linked to a diaphragm or bellows. Either diaphragm or bellows type operate in a like manner. Several types of pneumatic time-delay relays are available. In one type time delay begins when the solenoid coil is energized; in another, time delay begins when the coil is deenergized; in a third type a time delay occurs both when the relay is energized and when deenergized; in a fourth type two time-delay periods are provided. Other combinations are also possible.

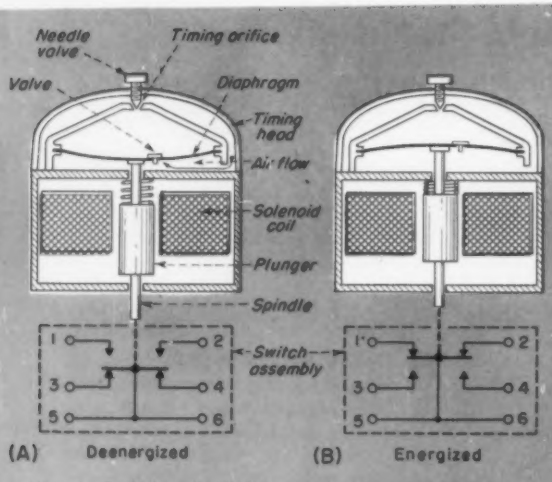


Fig. 2—Basic functional diagram of pneumatic time-delay relay with delay when coil is energized. (A) Deenergized position of core and diaphragm and switch contacts. (B) Energized position, after time delay has elapsed.

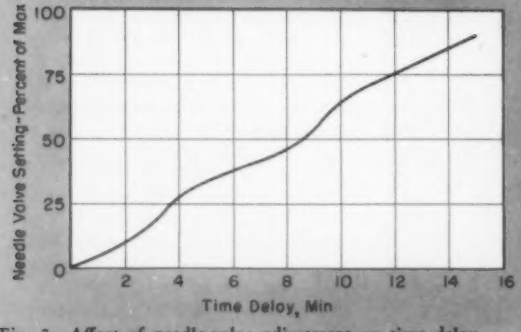


Fig. 3—Affect of needle-valve adjustment on time delay.

Relay Function

The basic functional parts of a diaphragm-type relay, in which time delay begins when the coil is energized, are shown in Fig. 2. This relay consists essentially of a pneumatic timing head, a solenoid coil and plunger, and a contact assembly. In operation, when the solenoid coil is not energized, weight of the plunger plus the spring force hold the timing-head diaphragm in a down position to commence a timing cycle, as shown in (A). In this position, and during the timing cycle, the valve in the diaphragm remains closed, effectively sealing the diaphragm.

Fig. 1—Pneumatic time-delay relays, consisting of a pneumatic timing head, a solenoid assembly, and contact assembly. They can be used for delays of a fraction of a second to 15 minutes. (A) With this type, time-delay starts when solenoid coil is energized (slow make-instantaneous break); at end of time delay switch contacts are transferred. (B) In this relay time delay starts when coil is deenergized (instantaneous make-slow break). (C) Auxiliary switch mounted on side of this relay provides electrical interlock so that relay can be used with momentary-type push buttons instead of conventional switch. (D) Adjustable auxiliary switch mounted on bottom of this unit provides two time delays; auxiliary switch operates first, main contacts next. (E) Hermetically-sealed pneumatic relay for use in aircraft.

How pneumatic time-delay relays operate; performance characteristics; contact arrangements for standard and non standard relays; typical applications.

When the solenoid is energized the plunger is pulled upwards, exerting an upward force against the diaphragm and forcing air through the timing orifice. The velocity with which the air passes through the orifice, and consequently the length of the time delay, are controlled by adjustment of the needle valve. At the end of the delay period a collar on the lower end of the solenoid spindle trips a snap-action switch, breaking contacts 3 and 4 and closing contacts 1 and 2. This is shown in (*B*).

The switch remains in this position until the solenoid is deenergized, at which time weight of the core plus the spring force pull the diaghragm downwards; the diaphragm valve opens, admitting air into the chamber, and the diaphragm and contacts are almost instantly restored to the original deenergized position shown in (A).

Penumatic time-delay relays in which the time delay begins when the solenoid is deenergized are constructed so that solenoid function is essentially the reverse of that shown in Fig. 2. When energized, the diaphragm is held in the position shown at (A).

Pneumatic time-delay relay timing heads are sealed and dustproof. Dust, temperature changes, humidity changes, and variations in supply voltage or frequency do not materially affect their accuracy which is within ±10 per cent on repeated operation at the same setting. Time-delay adjustments can be changed and readjusted to previous settings and still maintain a ±10 per cent accuracy. Fig. 3 shows the amount of change in timing interval as related to percentage advancement of timing adjustment for a 15-min. delay relay.

Table I—Contact Ratings, Amp

Voltage of Controlled Circuit	Contact Arrangement	
	SPDT Double Break	DPDT Single Break
0–32 dc	5	10
110–220 dc	0.1	0.2
115, 60 cycle	5	15
230, 60 cycle	3.3	10
440–550, 60 cycle	1.6	5

These devices perform within a temperature range of minus 65 F to plus 165 F. Substantial changes in altitude after the time delay for a given setting, so a hermetically-sealed relay is used for aircraft. Explosion-proof enclosures are available for use in hazardous atmospheres. Solenoid coils for these relays are available for use on dc from 6 to 300 volts, and on ac from 6 to 550 volts, or 60 or 25 cycles.

Contact Arrangements

Standard pneumatic time-delay relays operate integral single-pole-double-throw (SPDT) or double-pole-double-throw (DPDT) contact arrangements; non-standard units are available with more complex arrangements. In addition, units are available which have auxiliary switches which can be used to operate additional circuits, or to provide greater flexilibity of relay control. Fig. 4 shows diagrams of typical contact arrangements, while Table I lists contact current ratings, based on resistor loads. Table II lists typical relay operating functions available with various contact arrangements.

Applications

Many applications of pneumatic time-delay relays are found in motor-control functions. Some typical problems solved using these devices are:

Problem: To delay starting a main machine-drive motor until critical bearing areas are prelubricated by pressure from lubricating system.

Solution: Use of time delay relay in which delay starts when coil is energized provides needed function; see Fig. 5. When oil pressure switch closes, relay coil *M-M* is energized and time delay begins. Solenoid valve is simultaneously energized, permitting lubrication flow and prelubrication of required areas. When time delay expires, relay switch contacts are transferred, closing contacts 1 and 2, energizing motor starting coil and starting motor.

Problem: Where several large motors must be started at once, such as a rolling-mill type of operation, simultaneously placing all motors across the line draws excessive line current and provides possibility of motor burnout due to low voltage.

Solution: In this example, shown in Fig. 6, two time-delay relays with a two-step delay are connected to start five

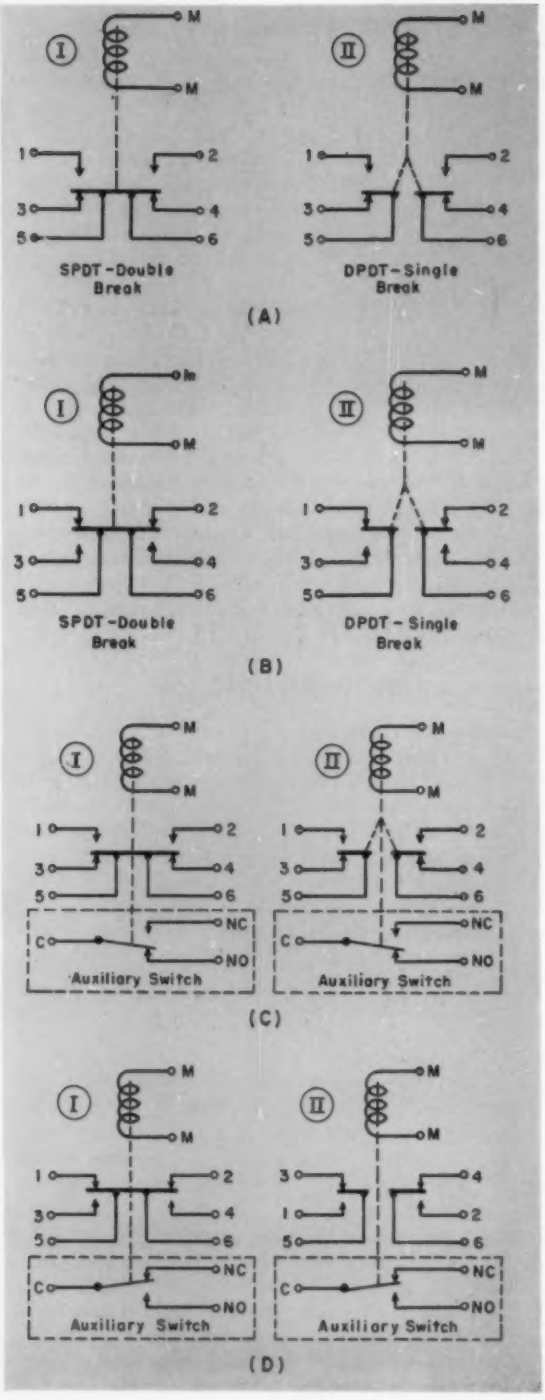


Fig. 4—Various types of switch and contact arrangements. Mechanical linkage of solenoid and central moving contact or contacts is indicated by dashed line. All relays are shown in deenergized position. (A) For this type of relay time delay begins when energized. (B) Time delay begins when deenergized. (C) This relay is identical to (A) except that an auxiliary sensitive snap-action switch has been added to provide additional switching functions described in text. (D) This relay is identical (B) with auxiliary switch added as in (C).

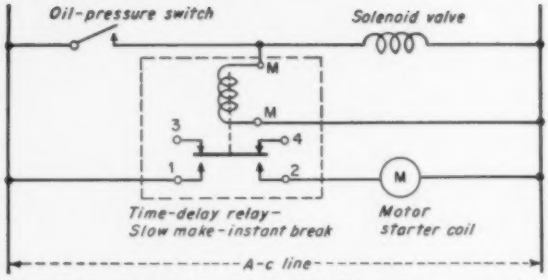


Fig. 5—Slow make-instant break time-delay relay connected to delay starting of main machine-tool drive motor until lubrication has been applied to critical areas controlled by solenoid valve. Circuit is shown in deenergized condition.

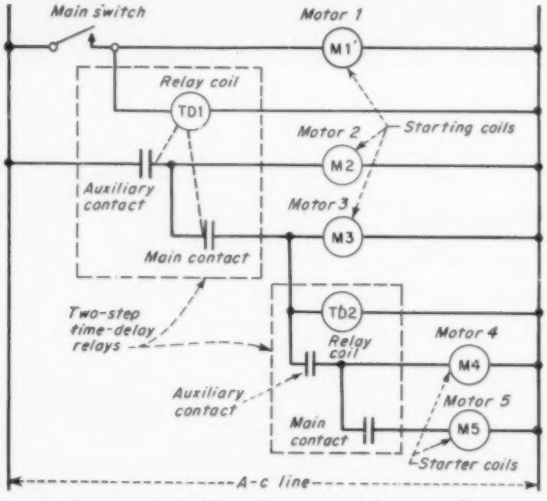


Fig. 6—Two-step time-delay relays connected to provide sequential starting of five motors. Time delays begin when relay coils are energized. Circuits are shown in deenergized condition.

Table II—Relay Operating Functions and Contact Arrangements

Relay Type	Contact Arrangement	Refer to Fig. 4
Slow make—Instant break	SPDT—Double Break	(A) I
Slow make—Instant break	DPDT—Single Break	(A) II
Instant make—Slow break	SPDT—Double Break	(B) I
Instant make—Slow break	DPDT—Single Break	(B) II
Slow make—Instant break, plus instant break—make contact	SPDT—Double Break	(C) I
Slow make—Instant break, plus instant break—make contact	DPDT—Single Break	(C) II
Instant make—Slow break, plus one instant-make contact plus one time-delayed contact	SPDT—Double Break	(D) I
Instant make—Slow break, plus one instant-make contact plus one time-delayed contact	DPDT—Single Break	(D) II
Two-step delay or momentary impulse	SPDT—Double Break	(C) I
Two-step delay or momentary impulse	DPDT—Single Break	(C) II
Instant make, two-step delay or momentary impulse on drop out	SPDT—Double Break	(D) I
Instant make two-step delay or momentary impulse on drop out	DPDT—Single Break	(D) II
Adjustable delay in both directions—make and break	SPDT—Double Break	(A) I
Adjustable delay in both directions—make and break	DPDT—Single Break	(A) II
Slow make, proportional break, and remake	SPDT—Single Break	(A) I
Slow make, proportional break, and remake	DPDT—Single Break	(A) II
Approx. equal time delay in both directions—make and break	SPDT—Double Break	(A) I
Approx. equal time delay in both directions—make and break	DPDT—Single Break	(A) II

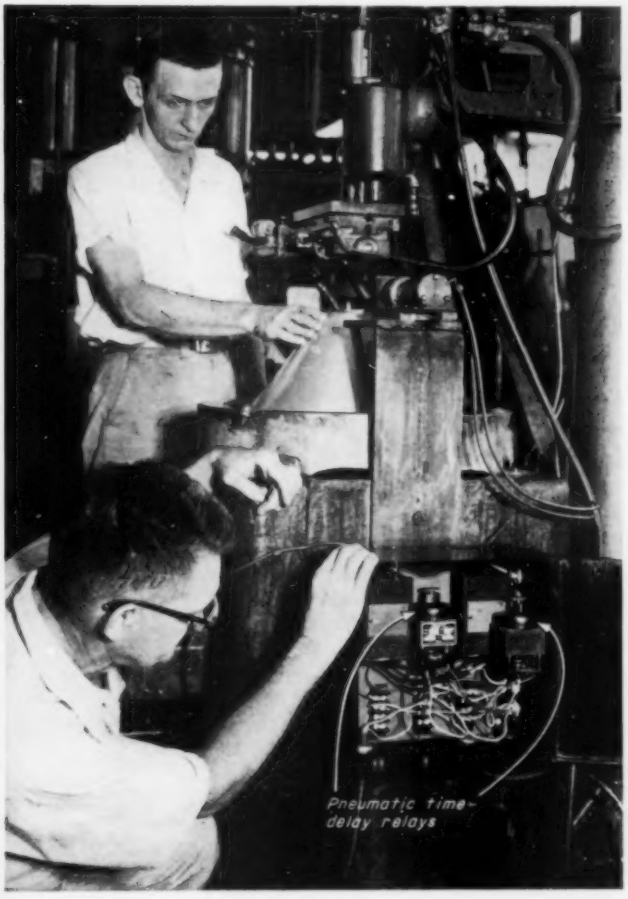
motors sequentially. Time delay starts when relays are energized. Diagram shows the circuit in deenergized condition.

When main switch is closed, starter coil of motor *1* and relay coil *TD1* are energized. Motor *1* starts up and at the end of the desired time delay, say 20 sec, the auxiliary contact of *TD1* closes, energizing starter coil for motor 2. At the end of an additional 20 sec the main relay contacts close, starting motor 3 and energizing the coil of second time-delay relay *TD2*. In similar fashion *TD2* repeats the cycle, starting motors *4* and 5 in sequence.

Fig. 7 shows details of a machine tool in which a roll-forming operation and a trimming operation are sequentially timed by using two pneumatic time-delay relays.

MORE ABOUT CONTROL COMPONENTS—Earlier articles on the selection and application of relays and control components for motor control and automatic control function: "Safety in D-C Motor Controls," in December page 193, describes relay systems for preventing injury to personnel, mechanical damage, and fire from overheating. "Magnetic Amplifiers", August 1955 page 129, discusses the advantages and limitations of magnetic amplifiers for switching, voltage control, and current control; presents a critical evaluation of input-signal requirements, power output, and response time in relation to the performance of rheostats, variable transformers, relays, vacuum tubes, gas tubes, and rotating amplifiers. "Pilot Control Devices", May 1955 page 187, explains how initiating, selecting, and interlocking functions can be performed by manual or automatic switches. Basic pilot-control devices for automatic control are described, and data on current ratings of standard devices are included. "Motor Overload Relays", January 1955 page 177, presents a fundamental approach to the selection of the proper types and ratings of bimetal thermal overload protection for electric motors.

A special report, "Mechanical Components for Automatic Control", September 1954 page 169 is a comprehensive discussion of the characteristics and applications of rotating mechanical components often required in automatic control systems; article includes extensive data on various types of electrically-actuated clutches. "Air-Electric Relays Link Pneumatic and Electric Control Systems", April 1954 page 197, describes the operation, types, and application of electric-pneumatic relays for electrical control of pneumatic circuits and pneumatic-electric relays for pneumatic control of electrical circuits. Also, "Circuits and Applications of Contactor Control Devices", April 1953 page 204, describes the use of relays and contactors as controlling devices; typical applications described: speed, voltage, and temperature control.



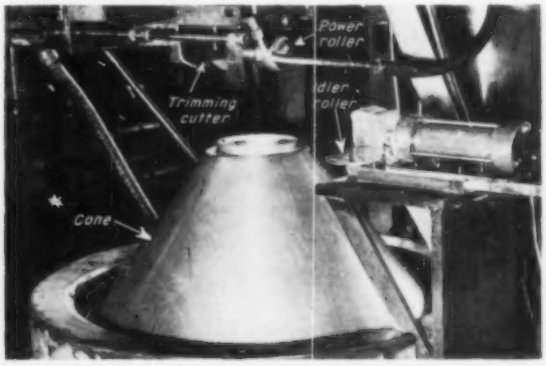
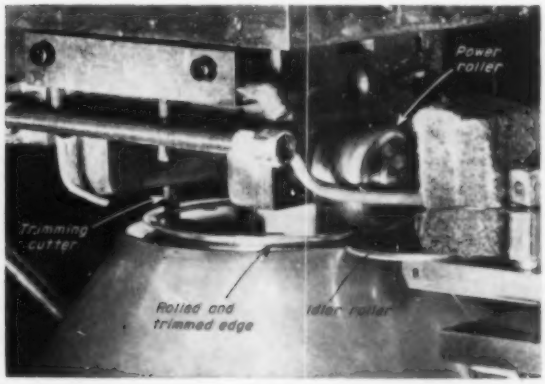


Fig. 7—(A) Special machine used for roll-forming and trimming top bead on cone used for shield over base of airport light. Pneumatic time-delay relays, located in control box on side of machine, control roll-forming and trimming operations. (B) Cone in position for machining. Idler roller at right is driven forward by cylinder to rest against unfinished top cylindrical section of cone. Power roller and cutter assembly at top moves down into position for roll-forming operation. (C) Power roller moves from center of cylindrical portion outwards, rolling metal over idler roller; time-delay relay times duration of rolling operation. At end of this period power roller lifts, cutter at rear moves in to trim rolled flange; second time-delay relay controls length of trimming period.



a, b, d	follower guide dimensions, in.
c	distance from cam center to follower arm pivot, in.
F	force at end of follower stem, lb
F_a	acceleration force, lb
h	total travel of follower, in.
J	angular mass moment of inertia, in.-lb-sec^2
l	length of follower arm, in.
n	cam speed, rpm
N	normal load between cam and roller, lb
O	cam shaft center
P	work load (force on cutting tool, gas force, frictional drag of external forces, etc.), lb
R	radius measured from cam shaft center to follower roller center, in.
R_o	minimum cam radius, in.
S	counterbalancing spring load, lb
T	torque on swinging follower, in.-lb
T_a	acceleration torque, in.-lb
T'_c	maximum cam shaft torque, in.-lb
y	follower displacement, in.
W	total dead weight of moving parts of cam system including weight of roller and stem, lb
α	pressure angle, deg
β	cam angle, deg
ζ	angle between follower stem and the vertical, deg
μ	coefficient of friction between follower and guides

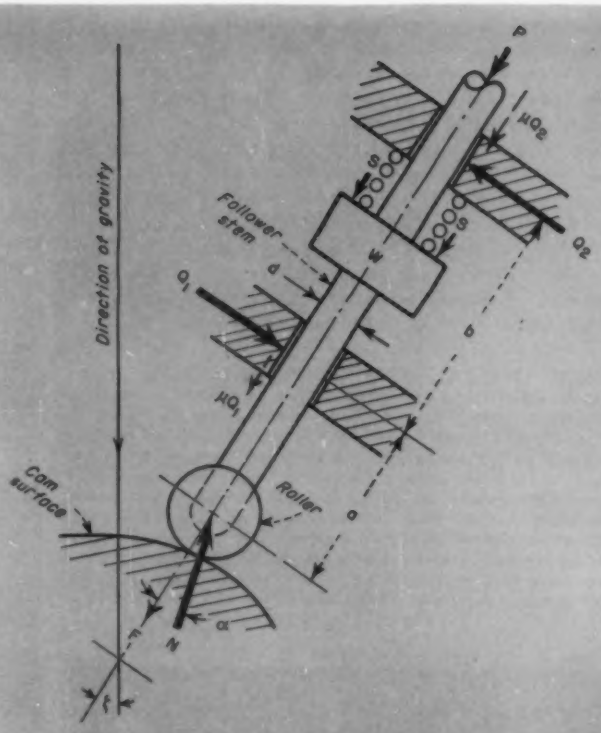


Fig. 1—Forces acting in a radial follower system. Direction of friction forces, μQ_1 and μQ_2, are opposite to direction of motion. Force F causes shear load on roller pin.

PLATE CAM DESIGN

. . . *evaluating dynamic loads*

M. KLOOMOK and R. V. MUFFLEY
International Business Machines Corporation

AFTER THE PROFILE and the size of a cam is tentatively determined, the corresponding dynamic loads in the cam system are calculated. This information is used to: (1) dimension the linkages, (2) select a roller follower, (3) determine the torque on the cam shaft, and (4) compute the maximum stress on the cam surface.

Loads in a typical radial cam follower system are indicated in Fig. 1. Force F on the end of the follower is the resultant of several forces (excluding friction forces):

$$F = W \cos \zeta + F_a + P + S \qquad (1)$$

The value for F can be used directly to check shear loads on clevis pins in the mechanism and buckling of the follower stem. It is also used to determine the normal load N between cam and roller using the following expression developed in Part II of this series (May 1955):

$$N = \frac{Fb}{b \cos \alpha - (2\mu a + \mu b - \mu^2 d) \sin \alpha} \qquad (2)$$

Eqs (1) and (2) are valid at any point throughout the motion. If a linkage is used between the work load and cam stem, the value for P should be computed to include the mechanical advantage of the linkage. Generally, for an exploratory or rough calculation the values of P, S, and a are taken at the point of maximum acceleration while, for α, the maximum value is used. By using α_{max}, even though

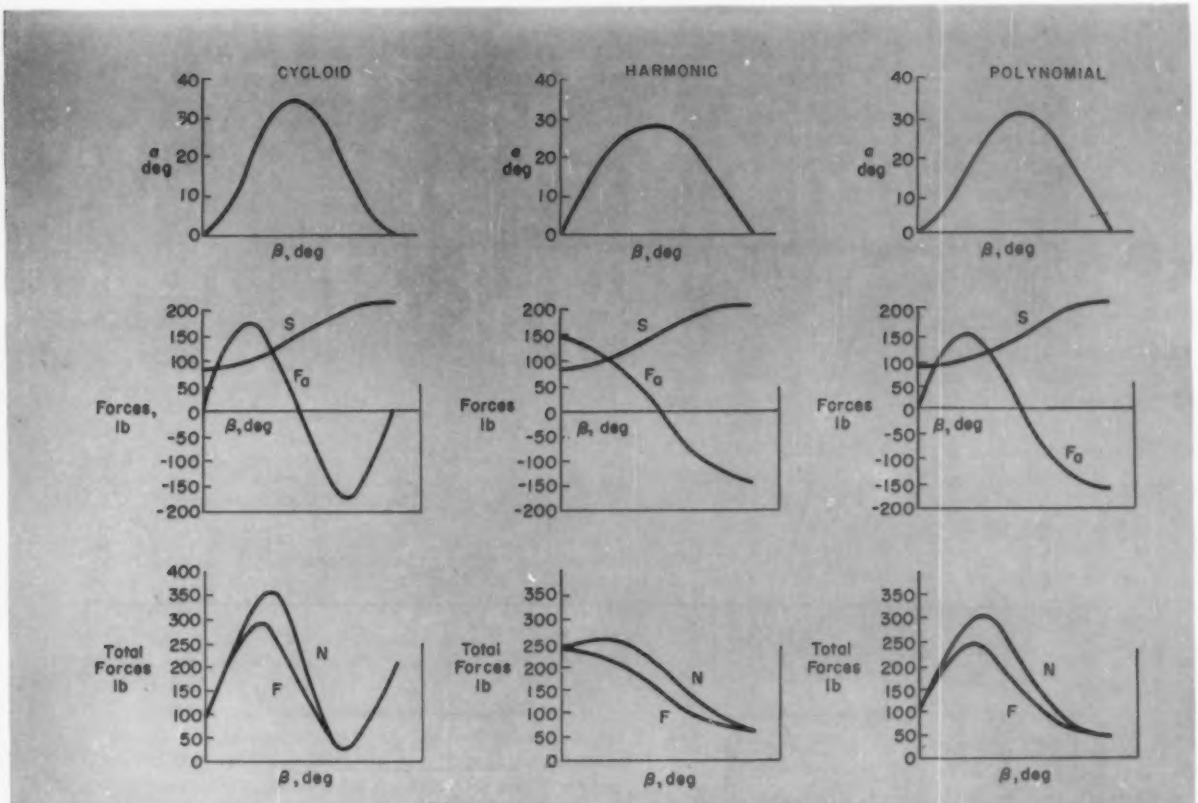


Fig. 2—Effect of various cam profiles on pressure angles and forces.

Previous articles of this series describe three basic steps in cam design: Part I—Selecting the cam profile (February 1955, page 156); Part II—Determining the maximum pressure angle (May 1955, page 155); and Part III—Calculating the minimum radius of curvature (September 1955, page 187). This article evaluates the loads in a cam system, including the effect of weight and frictional drag of moving parts, spring loads and pressure angles on radial and swinging follower cams.

not usually occurring at the point of maximum acceleration, a more conservative design is obtained. However, whether or not this procedure will give maximum values of N depends on S and P which are variables and may have maximum values at other cam angle positions. Fig 2 shows the effect of different cam profiles on α, F_α and S, and on the total force characteristics arising from acceleration and spring forces only. Force P can be added with the spring force if known.

The alternative to an approximate computation is a force analysis over the entire acceleration portion of each rise, which can be done either analytically or experimentally. In such an analysis, N and F are both plotted against β because their maximum values may not occur at the same point.

Sample Calculations

A design procedure is illustrated by the example of a feed slide cam for a small punch press. The known data are: W = 3 lb; n = 250 rpm; a = 2 in.; b = 6 in.; d = 1.5 in.; h = 1.5 in.; α = 35 deg (max); ζ = 30 deg; μ = 0.15; β = cam angle during which feed occurs = 30 deg; profile of cam is cycloidal (profile c 5 in Part I of this series, February 1955) with a dwell after the rise; angle during which feed is returned = 30 deg.

Solution:

1. Determine, t, time of event in milliseconds.

$$t = \frac{\beta\,(60)\,(1000)}{n\,(360)} = \frac{30\,(60)\,(1000)}{360\,(250)}$$

t = 20 millisec

Fig. 3—Nomogram for determining maximum inertia force in a radial follower or maximum inertia torque in a swinging follower cam system. Nomogram is constructed for a full cycloidal profile; for other types multiply by 0.78 for full harmonic and 0.84 for full eight-power polynomial. Dotted line applies to radial follower example on page 181.

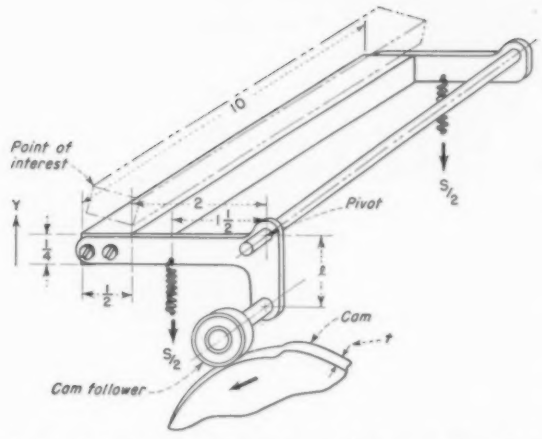


Fig. 4—Swinging cam follower system. The cam is used in a punched card feed mechanism. Timing diagram is shown in Fig. 5. Displacement y refers to the point of interest.

2. Determine F_a maximum inertia force, by locating $t = 20$, $W = 3$, $h = 1.5$ on the nomogram in Fig. 3; obtain: $F_a = 170$ lb.

3. Determine P. The work load during rapid advance is primarily friction; therefore: $\mathbf{P} = \mu \mathbf{W} \sin \zeta = (0.15)\ (3)\ (0.5) = 0.23$ lb.

4. Determine S, spring load. S must be large enough to prevent the follower from jumping off the cam at any time and therefore should be greater than the combined maximum acceleration and friction load forces. Point of maximum deceleration for a cycloidal profile is at the ¾ position ($y = \frac{3}{4}\ h$).

$$S > F_a - P - W \cos \zeta$$
$$S > 170 - 0.23 - 3(0.866)$$
$$S \geqq 180 \text{ lb}$$

Some initial spring tension is desirable during the dwell in the retracted position to supplement gravity and to assure that the roller will stay on the cam despite vibration. As the initial tension is increased, the spring rate is decreased to keep the same spring load at the ¾ position. This increases the fatigue life of the spring. An increase in initial tension, however, increases the spring load at the point of maximum acceleration, $y = \frac{1}{4}\ h$. For this problem, an initial tension of 90 lb is arbitrarily selected, giving a spring rate of $(180 - 90)/(\frac{3}{4})\ (1.5) = 80$ lb/in. Maximum spring load is $90 + (80)\ (1.5) = 210$ lb, and the ratio of minimum to maximum spring load is 0.43.

The value of S is calculated at the ¼ position (point of maximum acceleration) as $90 + (80)\ (\frac{1}{4})\ (1.5) = 120$ lb.

5. Determine **F**, the follower force, by using Eq (1):

$$F = 3(0.866) + 170 + 0.23 + 120 = 293 \text{ lb}$$

6. Determine N, the normal force on the cam. Pressure angle at the ¼ point can be determined from a layout of the cam or estimated by inspection of Fig. 2:

$$\alpha_{¼} = 0.5\ \alpha_{max} = (0.5)\ (35) = 18 \text{ deg}$$

From Eq (2):

$$N = \frac{(293)(6)}{(6)(0.95) - [(2)(0.15)(2) + (0.15)(6) - (0.15)^2(1.5)]} = 420 \text{ lb}$$

7. Review: A number of approximations have been used in these calculations. If cam or roller loading is later found to be critical, one or more of the following steps can be taken:

(a) Refine calculations for a more accurate picture throughout the stroke.

(b) Reduce initial tension of spring to 30 lb. This reduces spring force at ¼ point to 80 lb and lowers F to 253 lb, N to 363 lb.

(c) Replace counterbalancing spring with a positive cam.

(d) Increase (if possible) time of event or reduce throw, h.

(e) Increase size of cam.

Swinging Follower System

The approach is similar to that described for a radial follower but involves the additional step of determining the angular moment of inertia, J. Design of a cam for a bail assembly, Fig. 4, part of a punched card feed mechanism, illustrates the technique. Functional requirements are shown in the timing diagram, Fig. 5(A); displacement y refers to motion of outer corner of the bail, referred to as the "point of interest." Rotational machine speed (corresponding to the timing diagram) is 1000 rpm. Basic dimensions are shown in Fig. 4; it is desired to determine:

1. Estimated spring force, S
2. Length of follower arm, l
3. Location of cam center, O
4. Minimum cam radius, R_o
5. Thickness and material of cam
6. Radius of follower roller

SOLUTION:

First step is selecting suitable motion curves to fit requirements of timing diagram. According to Table I,

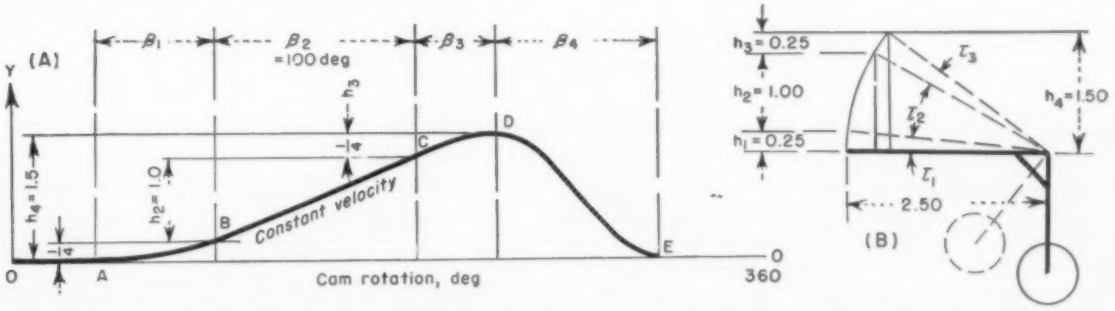


Fig. 5—(A) Timing diagram for the swinging follower cam in Fig. 4. Angles β_1, β_2 and β_4 are to be determined. (B) Trigonometric relationship between angular and vertical displacements of follower.

Part I, (February 1955), portion *AB* in Fig. 5 should be a half-cycloid, *CD* a half-harmonic, and *DE* a polynomial. The machine times β_1, β_3 and β_4 are computed as follows:

$\beta_2 = 100$ deg (given Fig. 5A)
$h_2 = 1$ in. (given Fig. 5A)

$$V_B = V_C = \frac{h_2}{\beta^2} = \frac{1 \text{ in.}}{100 \text{ deg}} = 0.01 \text{ in./deg}$$

To match velocities at *B* and *C*

$$\beta_1 = \frac{2h_1}{V_B} = \frac{2(0.25)}{0.01} = 50 \text{ deg}$$

$$\beta_3 = \frac{\pi h_3}{2V_c} = \frac{\pi(0.25)}{2(0.01)} = 39.27 \text{ deg}$$

To match accelerations at *D*

$$a_D = \frac{\pi^2 h_3}{4\beta_3^2} = \frac{5.2683 h_4}{\beta_4^2}$$

$$\beta_4 = \sqrt{\frac{5.2683(1.5)(39.27)^2(4)}{\pi^2(0.25)}} = 140.56$$

If these values of β are not acceptable, it would necessitate altering the speed of the cam to change v_2, or changing values of *h*. However, since $\beta_1 + \beta_2 + \beta_3 + \beta_4$ total less than 360 deg, the cam is operable and assumed acceptable.

Maximum pressure angle and minimum radius of curvature are calculated according to the techniques of Parts II (May 1955 and III (September 1955), after first establishing values of c = 1.75 in., $R_o = 1$ in., and $l = 0.66$.

The steel bail bar, which is the principal mass in the system, has a weight of: (10 in.) (¼ in.) (¼ in.) (0.281 lb/in.³) = 0.35 lb. Applying the parallel axis theorem to shift the axis of the moment of inertia

$$J_{\text{pivot}} = J_{\text{c-g.}} + X^2 W/g = 1/12\ W\ (a^2 + b^2)/g + X^2 W/g$$
$$= (1/12)\ (0.35)\ (1/4^2 + 1/2^2)/386 + (2.25)^2\ (0.35)/386$$
$$= 0.00462 \text{ in.-lb-sec}^2$$

Mass moment of the other moving parts, screws, shaft, roller and connecting links, can now be calculated, (see "Calculating Mass Moments of Inertia" page 215 of this issue for nomograms for quickly determining angular mass moments of inertia); however, in this instance it is a pointless refinement. Effect of the neglected parts can be included with sufficient accuracy by rounding off the mass moment of inertia to 0.005 in.-lb-sec².

To calculate loadings, the counterbalancing spring is considered first. Maximum deceleration occurs at *D*, the top of the rise. This is part of half-harmonic section *CD*. Correcting to full harmonic by techniques discussed in Parts II and III, $\beta_3' = 2\ \beta_3 = 78.5$ deg. Converting to millisec, *t* is equal to:

$$t = \frac{78.5\ (60)\ (1000)}{1000\ (360)} = 13 \text{ millisec}$$

To solve for torque at point *D*, a value of the angular displacement τ_3 of the follower from point *D* to *E* is needed. From Fig. 5(B)

$$\tau_3 = \text{arc sin } \frac{1.500}{2.500} - \text{arc sin } \frac{1.250}{2.500} = 6.7 \text{ deg}$$

Correcting to full harmonic:

$$\tau'_3 = 2\tau_3 = 13.4 \text{ deg}$$

Entering the nomogram in Fig. 3 with $\tau = 13.4$ deg, $t = 13$ millisec, and $J = 0.005$ in.-lb-sec², T_s is found approximately equal to (30) (0.78) = 23 in.-lb. The two springs must thus resist a torque of 23 in.-lb. To prevent the cam roller jumping at the peak use 25 in.-lb.

Maximum upward acceleration is seen to occur in either curve portion *AB* or *DE*. A check by the method above will reveal that the maximum acceleration torque for *AB* is 22 in.-lb, and for *DE* is 25 in.-lb. *DE* is thus the more critical; to this torque is added the torque of the springs. The springs are not extended as far as for point *D*, and spring torque will be approximately 15 in.-lb. A more specific value can be calculated if desired. Total torque therefore is deceleration plus spring torque, or: 25 + 15 = 40 in.-lb.

The basic *T-N* formula was given in Part II (May 1955):

$$N = \frac{T}{l \cos \alpha} \qquad \left(\begin{matrix}\text{neglecting} \\ \text{friction}\end{matrix}\right) \qquad (3)$$

The pressure angle is determined from Part II to be 46 deg and, from Fig. 2, the value of pressure angle α corresponding to the point of maximum acceleration is seen to be approaximately one-half α_{max}, or 23 deg. Thus,

$$N = \frac{40}{(1.5)\ (\cos 23 \text{ deg})} = 29 \text{ lb}$$

Maximum torque T'_c on the cam shaft can be calculated from the following equation, also derived in Part II:

$$T'_c = N\ R \sin \alpha \qquad (4)$$

The value of *R* corresponding to *N* is as follows:

$$R = R_o + h\left(\frac{1.5}{2.5}\right) \qquad (5)$$

where *h* is equal to ¼ h_4 and 1.5/2.5 is the leverage ratio. Thus,

$$T'_c = (29)\left[1 + \left(\frac{1.5}{4}\right)\left(\frac{1.5}{2.5}\right)\right](\sin 23 \text{ deg}) = 14 \text{ in.-lb}$$

Having evaluated *N* and T'_c the final steps in the design of the cam system are selection of the follower roller and calculation of the cam surface stress. These will be discussed in the next part of this series.

CHARGING that they took "business, customers, and good will" away from his company, a Buffalo industrialist is filing damage suits of: (1) $250,000 against the former chief engineer; and (2) $250,000 against the former chief engineer and six others collectively. The charge was made by A. D. Bausenbach, whose company since the incident is called the Buffalo Metal Container Corporation.

In addition to the suits, Mr. Bausenbach is asking for all the profits received by the company—Applied Design Co. and Adcon Corp.–founded by the defendants. The case will come up next spring. Although this is unusual in the industrial field, it is known that a New York advertising agency won a similar case for $300,000 against several of its former account executives.

Estimating Government Contracts

Guessing at material and manufacturing costs for government contracts may involve serious losses. A precise procedure is suggested with accounting sheets which provides estimates of material, labor, tooling and overhead expenses.

M. J. PHILLIPS Vice President, Ruffe, Inc.

THE DEFENSE DEPARTMENT of the United States is a very attractive customer for a large segment of American industry. Many concerns strive to get government business by every conceivable means often even courting bankruptcy and competition under these circumstances is tough. The margin for error is small because specifications are precise and profit is limited. Precise and complete estimating is imperative if serious losses are to be prevented. The following examples and Fig. 1 illustrate the competition faced by many contractors.

EXAMPLE NO. 1

Bid request was made for approximately 74,000 fire bombs. Many companies made estimates and bids on this order as it represented about $7,000,000 of business. The successful bidder offered a unit price of approximately $77.00 each. A complete and precise cost analysis of required materials (quotations from at least three suppliers) established that the cost of raw materials and purchased parts was $62,4213 per unit. Labor costs brought the price to $78.0203 per unit. Assuming an over-all operating overhead of 50 per cent of the labor cost (which is low for government work), and allowing for a minimum of production tooling the cost per unit would be at least $87.00 with no provision for scrap or rejects by government inspectors.

Difference between minimum possible cost of $87.00 and the bid price of $77.00 represents a loss of $740,000. The tragedies in this case are: the successful bidder is not worth any where near $740,000 and will probably go broke before completing the contract; the Defense Department will not receive needed material; many reliable concerns who had spent considerable time and money to prepare responsible bids will continue to operate at a loss due to lack of work.

EXAMPLE NO. 2

Bid request was made for a large number of structural steel units in which the exact amount and types of structural steel members were specified on the drawing. Since the tonnage of steel was large, mill prices were obtained from three steel mills. The price of material delivered at our factory door was more than the price offered by another bidder for the finished article crated and loaded in freight cars. The optimistic contractor who received this contract obviously expected to fabricate the units, paint, pack, crate, make tools and run the concern for nothing.

Estimating Procedure

A bid proposal should be completely studied to establish the exact requirements to be met, including applicable specifications covering qualification and test sampling, production testing, preservation and packaging requirements, etc. This is a time-consuming and dull chore, but it is imperative if accurate and complete cost estimates are to be prepared.

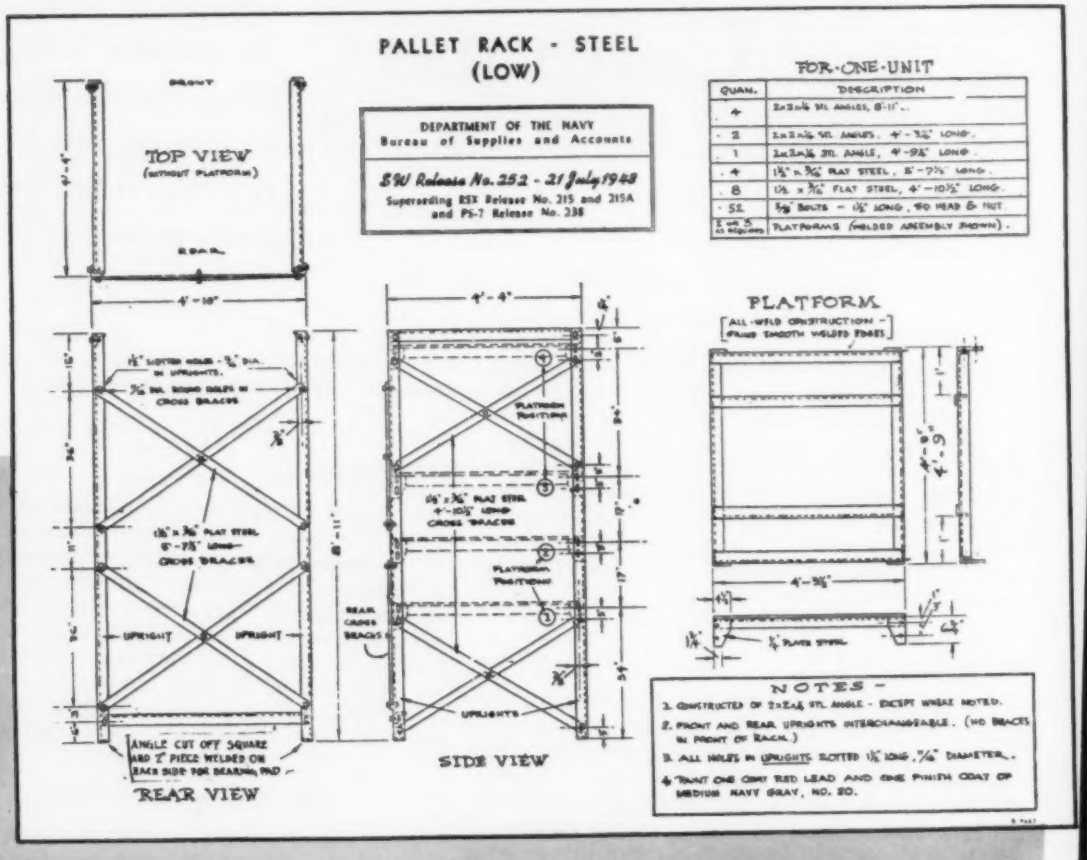
A Detailed and Summary Parts List should be prepared of the item to be priced. The form shown in Fig. 2 (top) has been found very helpful for this and other summary cost purposes.

A Summary Cost Sheet should be prepared to insure that all items and all costs are included. Fig. 2 (middle) represents one possible form that serves this purpose well.

A Preliminary Operation Sheet should be used to establish how to make each part, machine and tooling for each operation, time required for each operation, and condition and amounts of material required for the total number of parts to be fabricated. Fig. 2 (bottom) represents a suitable form for this purpose.

A Summary Materials List consisting of both raw materials and purchased parts should be prepared from the "Detailed and Summary Parts List" together with the "Preliminary Operation Sheets." This Summary Materials list can be given to the Purchasing Department to obtain prices and probable delivery schedules. Since accurate material prices and deliveries can be readily obtained, it is unwise to guess at such data, especially when prices and deliveries of materials fluctuate from time to time. There need be no guess work on material costs.

A projected production schedule should be established, based on predicted delivery of materials, estimated tooling time and production capabilities of tools available or proposed. Based on this production schedule, and others in effect or expected, the operating overhead of the company can be apportioned among all projects to establish an average monthly overhead cost to the bid proposal. Portions of existing overhead expenses already absorbed by existing contracts may be deducted from the total, and the balance charged to the new bid proposal.


PALLET RACK - STEEL
(LOW)
FOR ONE UNIT
DEPARTMENT OF THE NAVY
Bureau of Supplies and Accounts
SW Release No. 252 - 21 July 1948
Superseding RSX Release No. 215 and 215A and PS-7 Release No. 238
QUAN.
DESCRIPTION
TOP VIEW
(WITHOUT PLATFORM)
FRONT
REAR
REAR VIEW
SIDE VIEW
PLATFORM
ALL-WELD CONSTRUCTION - GRIND SMOOTH WELDED JOINTS
NOTES -
1. CONSTRUCTED OF 2"x2"x1/4" STL. ANGLE - EXCEPT WHERE NOTED.
2. FRONT AND REAR UPRIGHTS INTERCHANGEABLE. (NO BRACES IN FRONT OF RACK.)
3. ALL HOLES IN UPRIGHTS SLOTTED 1/2" LONG, 7/16" DIAMETER.
4. PAINT ONE COAT RED LEAD AND ONE FINISH COAT OF MEDIUM NAVY GRAY, NO. 20.

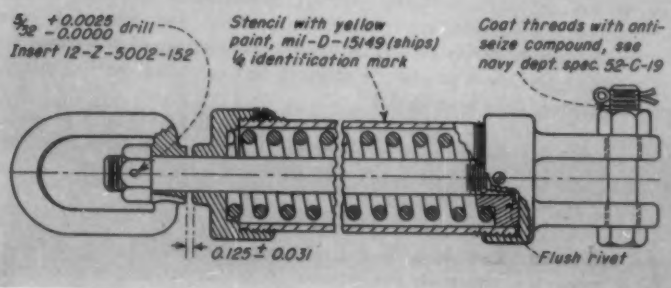
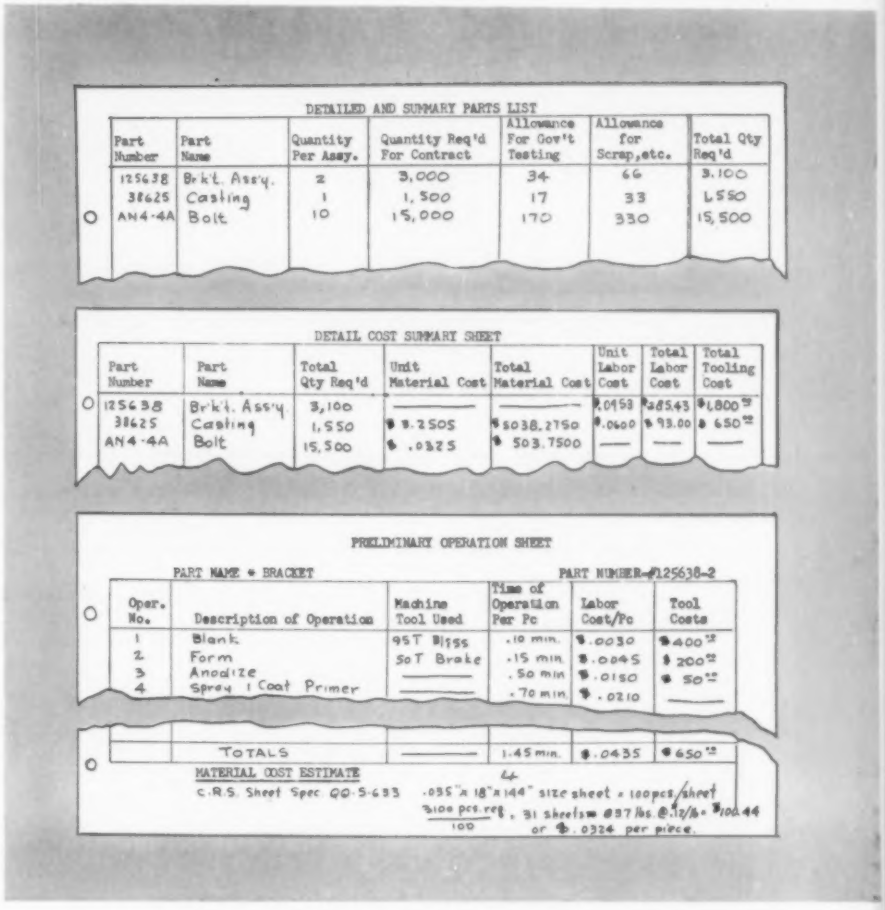

5/32 +0.0025 -0.0000 drill
Insert 12-Z-5002-152
Stencil with yellow paint, mil-D-15149 (ships)
1/4 identification mark
Coat threads with anti-seize compound, see navy dept. spec. 52-C-19
0.125 ± 0.031
Flush rivet

Fig. 1—Two examples of government contract bid proposals. The steel pallat rack (above) was estimated at a unit material cost of $40.87 not including scrap allowance. The lowest bid was $35.37 each FOB destination. The spring buffer (left) had a low bid of $3.40 each plus $2470.00 in tooling. Material cost was estimated by the author at $4.37 each to which must be added labor, tooling, packaging, freight, overhead and profit.

The major portion of overhead expense is relatively fixed in an established manufacturing concern regardless of how much direct labor expenditures are involved. Therefore, when a large amount of direct labor is being used the percentage of overhead is proportionately low. A wise estimator will endeavor to establish maximum rates of production possible so as to reduce the amount of overhead expense to be apportioned to each item produced. If a bid request calls for a monthly schedule of 2500 units per month, and the monthly overhead expense chargeable to the new job is $25,000, the unit overhead charge for each item would be $10.00. If, however, it were possible to produce at a rate of 5000 units per month, and it is not forbidden by the bid request, the unit overhead charge for each item would be approximately halved.

Proper determination and apportionment of operating overhead requires accurate data on existing overhead as well as good judgment and considerable foresight in the prediction and apportionment of future overhead expenses. To ignore the existence of such indirect operating costs, or to assume that they can be absorbed by means other than a realistic apportionment over projects in existence and bid upon, can only result in serious miscalculations and possibly bankruptcy.



DETAILED AND SUMMARY PARTS LIST

Part Number	Part Name	Quantity Per Assy.	Quantity Req'd For Contract	Allowance For Gov't Testing	Allowance for Scrap, etc.	Total Qty Req'd
125638	Brk't. Ass'y.	2	3,000	34	66	3,100
38625	Casting	1	1,500	17	33	1,550
AN4-4A	Bolt	10	15,000	170	330	15,500

DETAIL COST SUMMARY SHEET

Part Number	Part Name	Total Qty Req'd	Unit Material Cost	Total Material Cost	Unit Labor Cost	Total Labor Cost	Total Tooling Cost
125638	Brk't. Ass'y	3,100	———	———	$.0453	$285.43	$1800.00
38625	Casting	1,550	$ 3.2505	$5038.2750	$.0600	$ 93.00	$ 650.00
AN4-4A	Bolt	15,500	$ .0325	$ 503.7500	———	———	———

PRELIMINARY OPERATION SHEET

PART NAME ⊕ BRACKET — PART NUMBER #125638-2

Oper. No.	Description of Operation	Machine Tool Used	Time of Operation Per Pc	Labor Cost/Pc	Tool Costs
1	Blank	95T Bliss	.10 min.	$.0030	$400.00
2	Form	50T Brake	.15 min.	$.0045	$ 200.00
3	Anodize	———	.50 min.	$.0150	$ 50.00
4	Spray 1 Coat Primer	———	.70 min.	$.0210	———
	TOTALS	———	1.45 min.	$.0435	$650.00

MATERIAL COST ESTIMATE

C.R.S. Sheet Spec QQ-S-633 .035" x 18" x 144" size sheet = 100 pcs/sheet

3100 pcs. req'd / 100 = 31 sheets @ 87 lbs. @ 12/lb. = $100.44

or $.0324 per piece.

Fig. 2—Sample estimating sheets on which each part's material and labor cost may be estimated and totaled. In addition a summary materials list can be made up for purchasing department information.

Total cost is established by summarizing all items of cost from procedures above described. This would be the sum of: materials costs, direct labor costs, operating overhead costs, and tooling costs. If the bid specifies FOB destination, the freight rate per unit must be added. Selling price is established by adding the desired profit to the unit cost.

Profits are circumscribed by Armed Service Procurement or other regulations. The profit figure may vary from zero to 10 per cent of the total cost or portions of the cost. Some companies charge a profit on direct labor and overhead costs, others on all costs except tooling, and still others on all costs. No matter how precise or accurate a cost estimate may be, it is still subject to error and some allowance must be made either by deducting them from predicted profit or by adding a contingency factor.

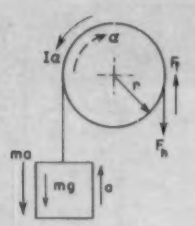
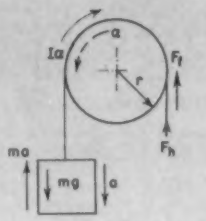
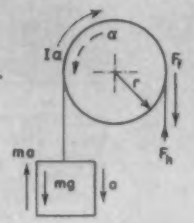
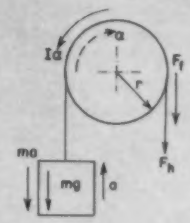
Good estimating should be accurate within two per cent and good cost control would insure this by using time estimates from the preliminary operation sheet as a guide on performance.

Procedures here recommended take time and cost a substantial amount, but the cost of preparing such estimates is the justified equivalent of sales and advertising expenditures made to obtain civilian business.

Advantages for careful preparation of cost estimates are:

1. The bid proposal, if accepted, will result in a profit.
2. All basic planning, tooling, scheduling, purchasing, material control, cost control, and accounting can be immediately initiated from the estimator's accumulated data and the work started immediately by all departments without delay.
3. Targets for costs and schedules can be immediately established and policed to insure maximum control of performance and costs. Standard cost accounting system would have established cost on each part for inventory control.
4. A system of records is immediately available and the maintenance of these records during the life of the contract provides necessary records for renegotiation or other government purposes as well as guidance on future work.

Table I - Force Equations

Hoisting and accelerating	Hoisting and decelerating	Lowering and accelerating	Lowering and decelerating
			
$\Sigma M_O = F_h r = mar + I\alpha + F_f r + mgr$	$\Sigma M_O = F_h r = mar + I\alpha - F_f r - mgr$	$\Sigma M_O = F_h r = mar + I\alpha + F_f r - mgr$	$\Sigma M_O = F_h r = mar + I\alpha - F_f r + mgr$
$F_h = ma + \frac{I\alpha}{r} + F_f + mg$	$F_h = ma + \frac{I\alpha}{r} - F_f - mg$	$F_h = ma + \frac{I\alpha}{r} + F_f - mg$	$F_h = ma + \frac{I\alpha}{r} - F_f + mg$
$F_h = ma + \frac{WR^2\alpha}{gr^2} + F_f + mg$ (1)	$F_h = ma + \frac{WR^2\alpha}{gr^2} - F_f - mg$ (2)	$F_h = ma + \frac{WR^2\alpha}{gr^2} + F_f - mg$ (3)	$F_h = ma + \frac{WR^2\alpha}{gr^2} - F_f + mg$ (4)

Because the acceleration and deceleration of a hoist follows the same basic equations that apply to all machines with high inertia and heavy starting loads, this dynamic analysis is a useful guide when designing for . . .

. . . Minimum Inertia

MARTIN A. BAER, KOEHRING COMPANY

In hoists, as in other types of equipment, one or more of the following conditions may result if the inertia of prime mover and transmitting machinery is not kept to a minimum: (1) Loss of power during accelerating and decelerating. (2) Sluggish and lagging response of control system. (3) Increased time per operating cycle. (4) Excessive wear of elements.

Schematically, the mechanics of hoisting equipment can be represented by a mass suspended from the rim of a flywheel, tending to rotate it as is shown in Fig. 1. The mass will move when torque is applied to the flywheel by either the load or prime mover. Then, to evaluate the overall inertia effect of the mechanism, the inertia of each rotating element must be referred to the center of the flywheel, which corresponds to the hoist drum shaft. This is done by evaluating WR^2 for each part and multiplying by the square of the speed ratio between it and the drum shaft. The torque applied by the prime mover can be referred to the drum shaft by multiplying by the inverse of the speed ratio.

Force Equations

Equations for applied and inertia forces can be derived by using the mass-plus-flywheel schematic diagram, Fig. 2, and taking moments about the center of the flywheel. The results are given by Eqs (1) to (4) in Table I. These equations can be summarized as:

$$F_h = ma + \frac{WR^2 a}{gr^2} \pm F_f \pm mg \quad (5)$$

The signs, positive or negative, for friction force F_f and load mg depend upon the condition of motion. Eq (5) applies to all conditions encountered during a complete hoisting cycle. For example, to find the lowering acceleration under the influence of gravity, the applied force of the prime mover is omitted and Eq (3) becomes

$$a = \frac{mg - F_f}{m + \frac{WR^2}{gr^2}} \quad (6)$$

The momentum which the load can attain is a function of the moving masses, WR^2/gr^2, and the velocities of these masses. The impulse force of the load on a relatively stationary object, F_i, depends upon how quickly these velocities can be made to change, that is, the instantaneous deceleration. For hoisting

$$F_i = ma + \frac{WR^2 a}{gr^2} - F_f - mg + F_h \quad (7)$$

For lowering, the cable will buckle at the first instant of impulse, and the total force of impulse will be

$$F_i = mg + ma \quad (8)$$

The maximum cable tension T occurs when the load is being raised and accelerated. From Fig. 2, the summation of moments and forces about the

Fig. 1

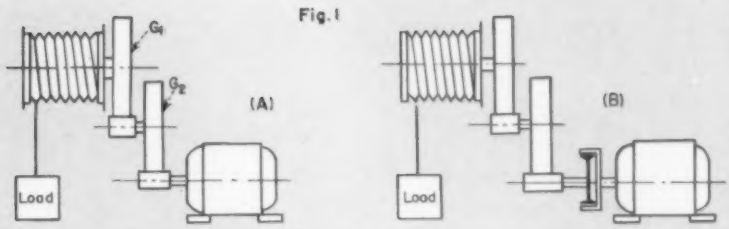


Fig. 1—In hoisting machinery, the effort is usually supplied by either an engine or electric motor. A reversing prime mover (A) transmits torque to a hoist drum through gearing. If prime mover is unidirectional, (B), a clutch is used to engage or disengage it from drum for hoisting, while lowering is done by gravity.

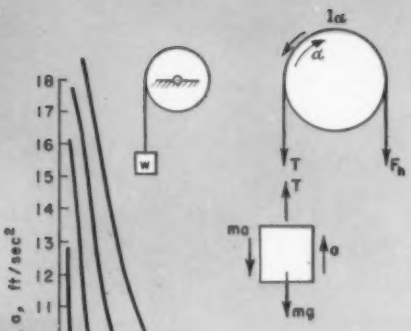


Fig. 2

Fig. 2—Equivalent system for hoisting machinery. To simplify solution of the dynamics problem, inertia and torque of all elements are referred to the drum shaft, by multiplying by the square and inverse of the speed ratio, respectively.

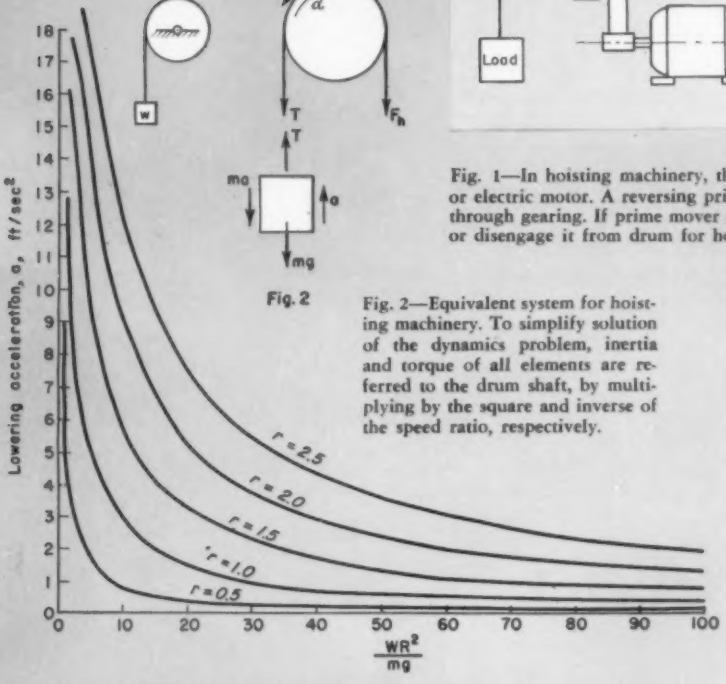


Fig. 3—Effect of inertia mass on lowering acceleration for five values of drum radius.

SYMBOLS

L	weight of load = mg
g	acceleration of gravit
m	mass of load = L/g
W	equivalent weight of flywheel
F_h	applied equivalent instantaneous force of prime mover
F_f	frictional force
a	instantaneous acceleration or deceleration of load
α	angular acceleration or deceleration of drum
I	equivalent moment of inertia at the drum = WR^2/g
R	equivalent radius of gyration of flywheel
r	drum radius
ma	inertia force of load
$I\alpha$	inertia torque of flywheel
$I\alpha/r$	inertia force of flywheel = $WR^2\,a/gr^2$

flywheel center and load, are:

$$\Sigma M_o = Tr + I\alpha = F_h r$$

$$T = F_h - \frac{WR^2\,a}{gr^2} \qquad (9)$$

$$\Sigma F_y = T = ma + mg \qquad (10)$$

To calculate T, these equations can be solved simultaneously.

The effect of inertia in the hoist machinery can be derived from Eq (6). Neglecting friction, the lowering acceleration under the influence of gravity becomes

$$a = \frac{mg}{m + \frac{WR^2}{gr^2}}$$

Curves in Fig. 3 are plotted for five different drum radii. They show the various accelerations for different ratios of equivalent WR^2 at the flywheel to the load. Also, they illustrate the effects of drum radius, inertia of the machinery and the load on the lowering acceleration.

EXAMPLE: mg = 1000 lb; equivalent WR^2 = 50,000 lb-ft²; drum dia = 3.0 ft.

Required: Maximum lowering acceleration and the required force to decelerate the load at the same rate.

Solution: $WR^2/_{mg}$ = 50,000/1000 = 50 from which a = 1.31 ft/sec². Neglecting friction, Eq (4) becomes

$$F_h = \frac{1000\ (1.31)}{32.2} + \frac{50{,}000\ (1.31)}{32.2\ (1.5)^2} + 1000 = 1945 \text{ lb}$$

The lowering acceleration could be increased to 2.3 ft/sec² by decreasing WR^2 to 30,000 or by increasing drum diameter to 4 ft.

It would seem, therefore, that the drum diameter should be as large as possible to decrease the over-all gear ratio, and thus reduce the loss of energy to the rotating mass. However, the limited torque of the prime mover dictates an over-all speed ratio to attain the required pull at the drum. In effect, therefore, increasing the drum diameter would also necessitate an increase in over-all gear ratio.

Effective hoist performance on material handling equipment dictates a definite maximum pull and speed relationship. Next to the load, the important factors are the allowable mechanical stresses in the supporting members of the system. After these values have been fixed, the hoisting effort and speed must be matched to the prime mover. Selection of the prime mover is influenced by: (a) speed-torque relationship and control; (b) inertia; (c) cost; (d) space requirement; and (e) efficiency. These requirements generally dictate using a high shaft speed at a relatively low torque. It is then necessary to add reduction gears to obtain the correct speed-torque relationship at the drum.

Electrohydraulics in Machine Tools

Last month the basic electrohydraulic system was described with its advantages as a machine tool design philosophy that offers many and varied opportunities for faster and more convenient production control.

This month specific Gebruder Heller designs are described. Each type of machine tool makes slightly different demands on its control system. A production milling machine, a large planer-miller, an automatic lathe and a special machine for machining crankshafts provide examples of the versatility of electrohydraulics.

A. DÜRR
Nürtingen

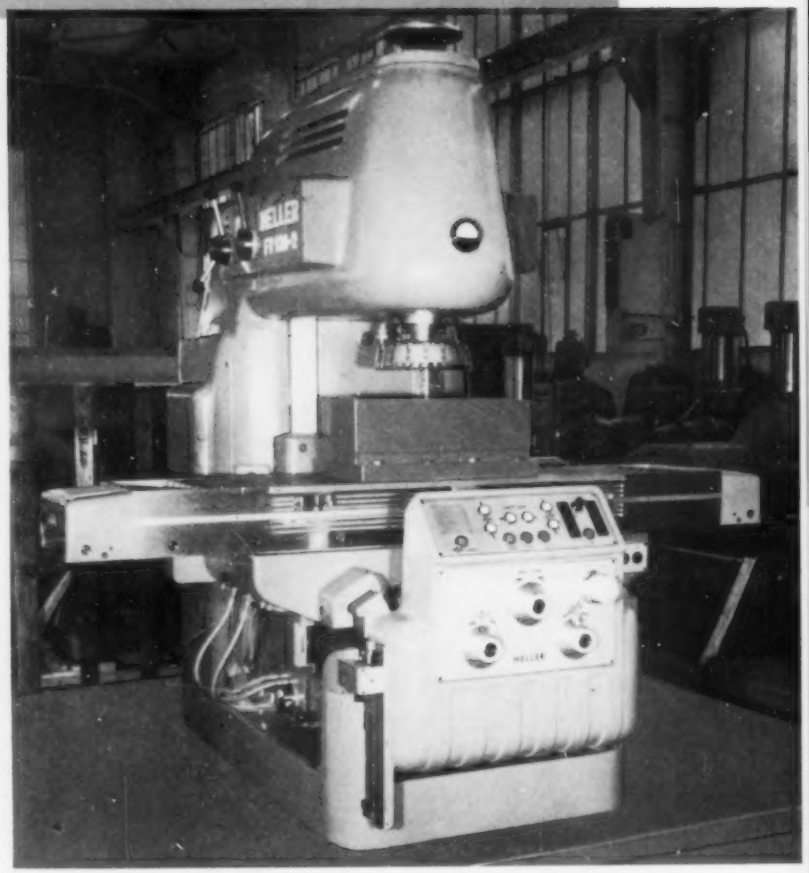


Fig. 1—Production milling machine, knee type, with electrohydraulic system.

PART II—APPLICATIONS

MACHINE TOOLS may be roughly divided into the general purpose type; which are broad in application and may be manually or automatically controlled, and the special type; adapted to mass production, automatically controlled, and often multi-stationed. With electrical components borrowed from modern communication techniques for control, and hydraulic components to provide the muscles, speed, accuracy, and safety may be achieved in both types.

General Purpose Machines

A machine much used in job and production work is the knee type milling machine. This machine strives for highly versatile application, often at the expense of output. The production milling machine shown in Fig. 1 is of unconventional design. It is remarkable for the hollow frame construction, anti-vibration cutter drive with high transmission power, and effective absorption

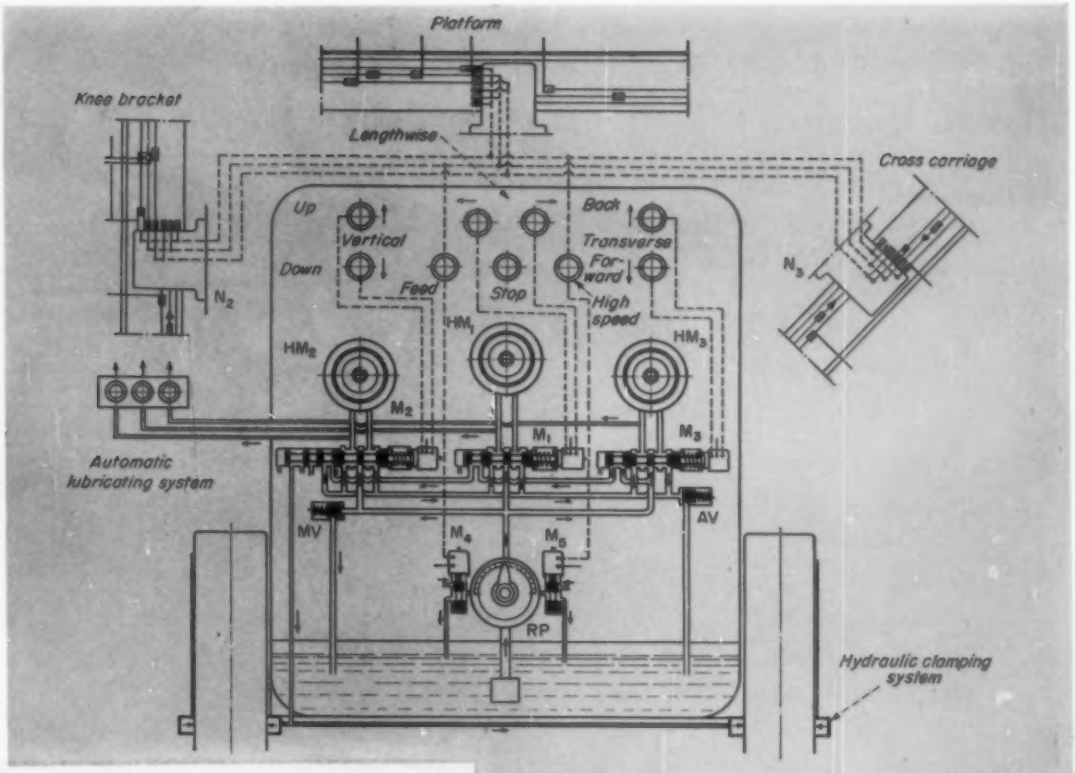


Fig. 2—Diagram of electrohydraulic system for milling machine of Fig. 1. HM—hydraulic motors, M—solenoid valves, MV—relief valve, RP—regulator pump—AV—drain valve, N—cam switch, E—high speed advance.

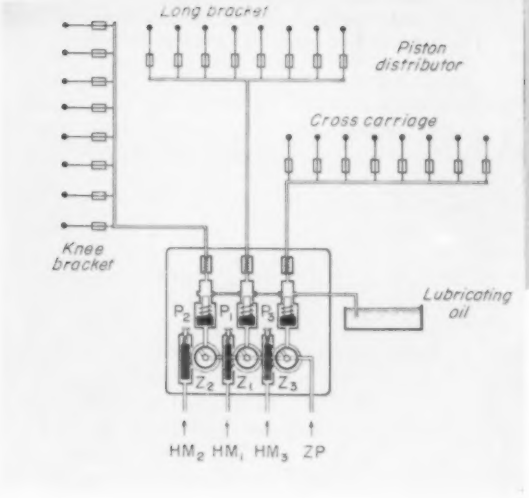


Fig. 3—Automatic lubricating system, HM_1 . . . HM_3—pressure impulses from hydraulic motors, ZP—gear pump, Z_1 . . . Z_3—counters, P_1 . . . P_3—lubricating oil pump.

of cutting stresses by special slide design. This machine has been successfully employed in hard-metal milling of steel.

Separate hydraulic motors have been supplied to control each direction of motion (lengthwise, transverse, vertical). The three motors drive screw spindles via appropriate reducing gears. The hydraulic system shown in Fig. 2 locks the knee and provides automatic lubrication of the guide ways. Lubrication is vitally important in high speed machinery and the guide ways especially require dependable lubrication. The schematic is shown in Fig. 3. For each moving machine part (platform, cross carriage, knee bracket) a separate hydraulically actuated pump is provided.

Lubrication is automatic after a number of slide cycles that can be adjusted on stroke counters. When the machine is stopped an automatic zero-setting device assures ample lubrication at the commencement of operation. The entire hydraulic unit is driven by a separate electric motor which also carries a fan for cooling the oil.

The electric control system operates on 24 volts dc and may be controlled manually with push buttons, by cams or programming as desired. An inclined operating panel shown in Fig. 4 carries the push buttons which control movements of the platform in longitudinal, transverse and vertical directions as well as its speeds in these directions. Note the pictorial labels on this panel.

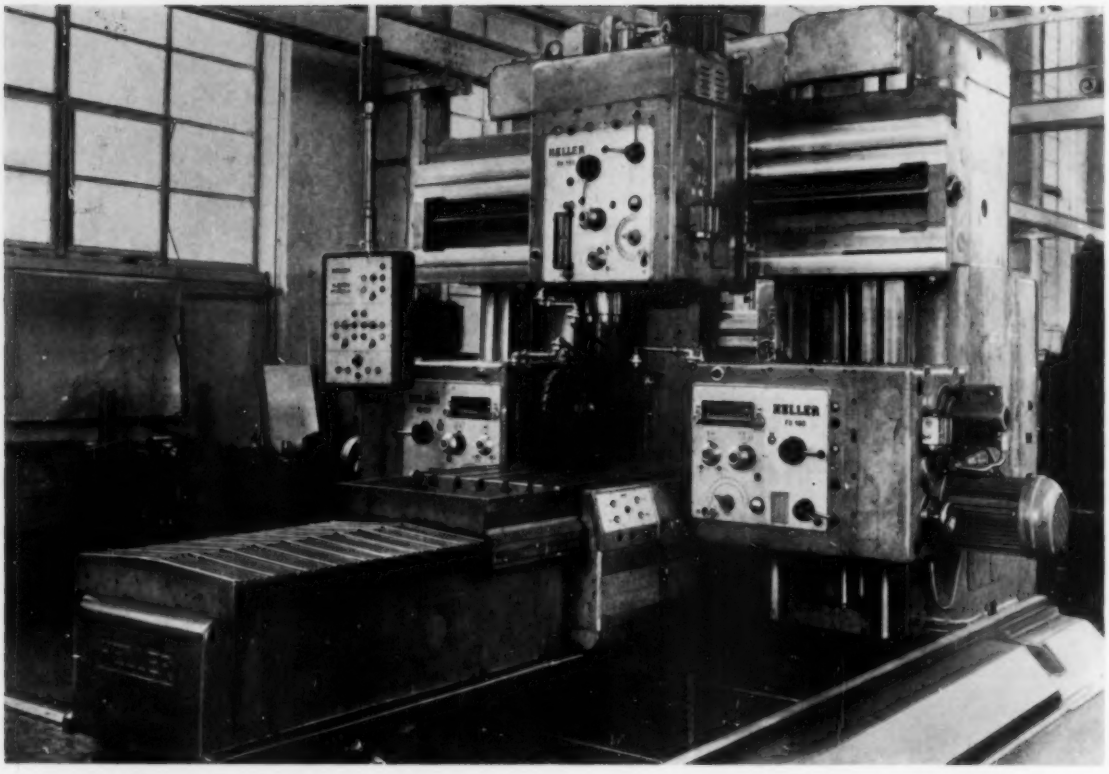


Fig. 5—Planer-miller with electrohydraulic system, three milling heads and pendent control.

Fig. 4—Operating panel with pushbuttons for motions and speeds of milling machine.

For automatic control a multicam switch is provided for each direction of motion. With this switch a preselected table location will be automatically reached when the switch has been actuated.

Programmed control provides for an entire sequence of such motions. Three basic units have been developed to serve this function and are interchangeable on the basic machine. The three units differ in complexity, automaticity, and number of operations which may be sequenced. The simplest can control up to ten phases of program and must be preset manually. The most complex is intended for infrequently modified mass production.

Copying control provides for machining of irregular shapes from templates or patterns accurately and smoothly. Additional hydraulic fixtures for revolving and tilting platforms or other attachments may be connected to the hydraulic system.

Electrohydraulic features can be applied in the same or similar manner to other machine tools. Thus the planer-miller shown in Fig. 5 also has a hydromechanical feed drive for the table as well as for the spindle and transverse movement of the milling head. This system includes hydraulic motors, regulating pumps, solenoid valves and hydraulic locking mechanisms for moving parts.

A sectional view in Fig. 6 shows the simple design of the feed unit for the table. Since an operating station for such large machines is subject to frequent changes of location, the entire control is mounted in an overhead traveling cabinet (Fig. 7).

To facilitate change of spindle speeds in varying job production, the gearing in this machine is equipped with magnetic clutches. The entire communications-current control system for the large electrohydraulic apparatus is contained in one control station similar to that of Fig. 8. It comprises nine standardized units, two for each milling head (speeds, hydraulic system) and one for platform drive (high speed, feed, feed adjustment). All control units are mounted on a hinged chassis using multiple knife-contacts. The whole wiring system employs the same convenient connection means.

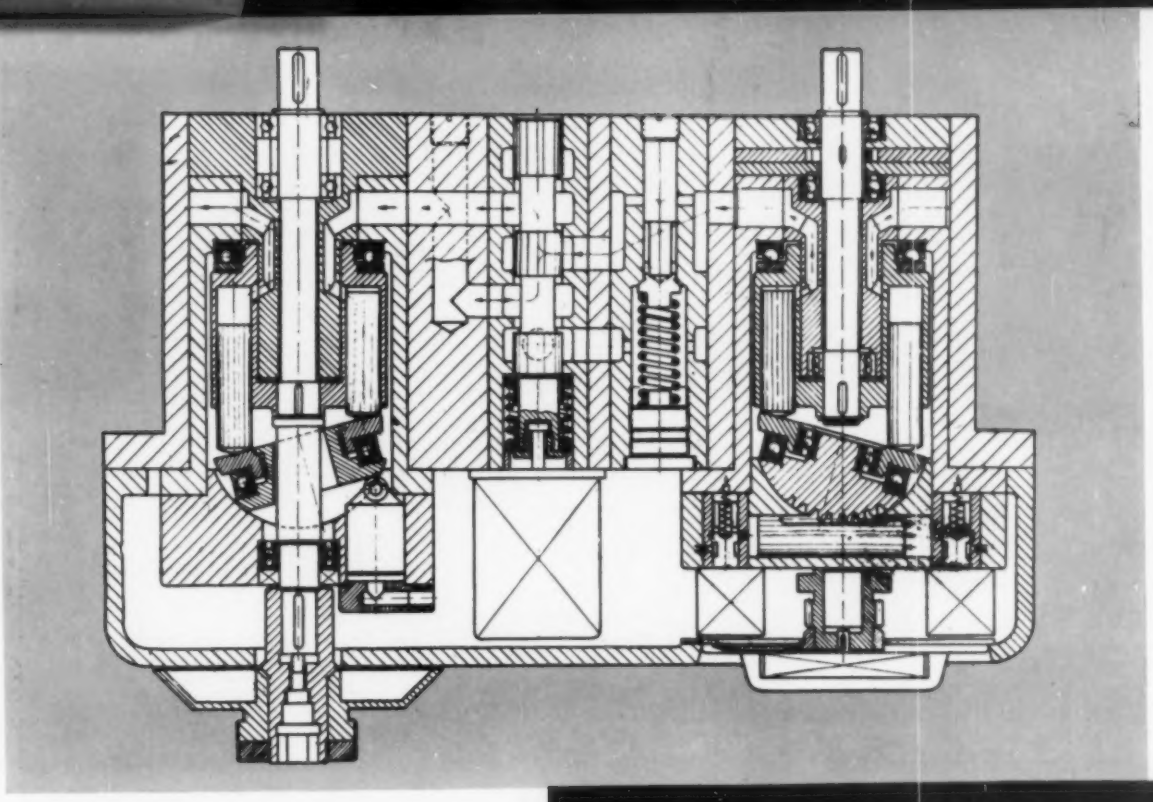


Fig. 6—Cross-section of hydraulic feed unit.

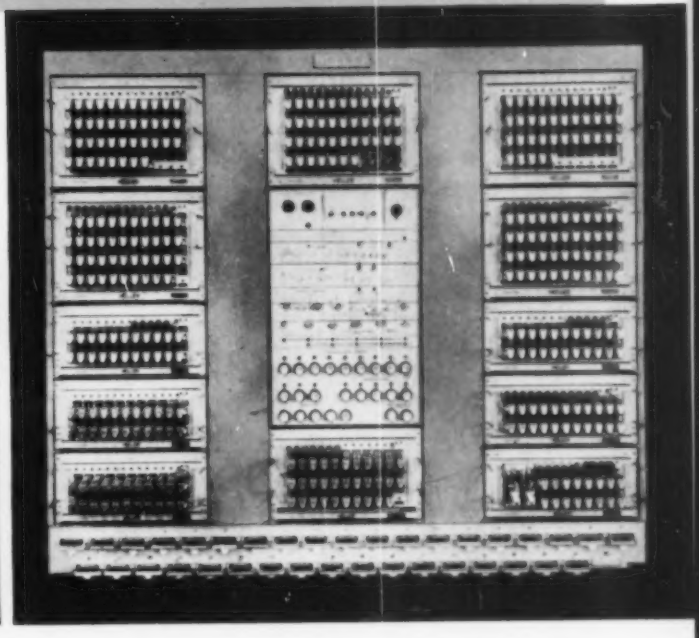
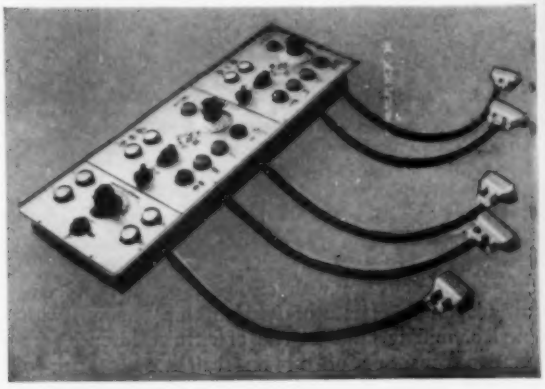


Fig. 8 (Right)—Control station of transfer machine with interchangeable standardized units.

Fig. 7—Cabinet for remote control of planer-miller.



General Purpose Automatic Machines

By appropriate application of the electrohydraulic principles its has been possible to revolutionize production on automatic machines as well. Pertinent principles may be understood from the following example of an automatic lathe with electrohydraulic system.

For setup purposes and to machine single parts, a manual control is necessary. Fig. 9 shows two versions, the upper with numerous push buttons, and below a simple arrangement with few control elements. The manual control system also includes the speed preselector (Fig. 10), a simple step switch with positions corresponding to the spindle speeds. The knob is moved axially to deliver a control impulse. The relay section is so arranged that all maneuvers for starting, slowing down the spindle, releasing the clutches and changing the speeds can be carried out with one operating control. For example, if a new speed is selected by turning the knob when the spindle is stationary, axial pressure and release will affect the start. Renewed pressure lets out

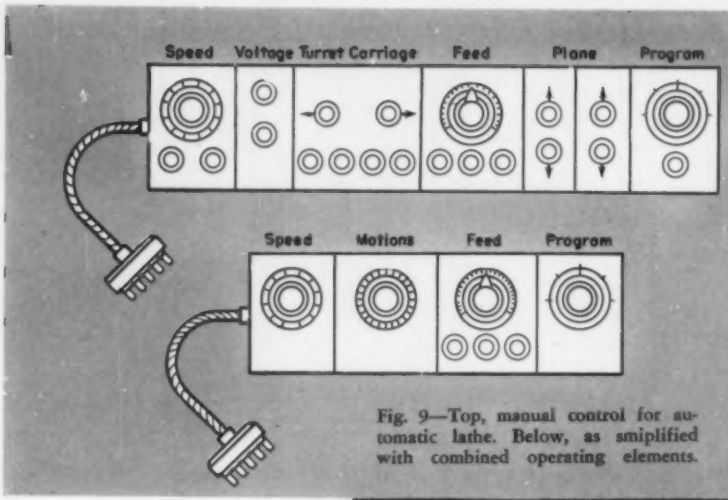


Fig. 9—Top, manual control for automatic lathe. Below, as smiplified with combined operating elements.

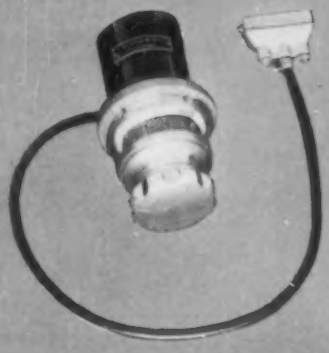


Fig. 10—Spindle speed selector for full speed control.

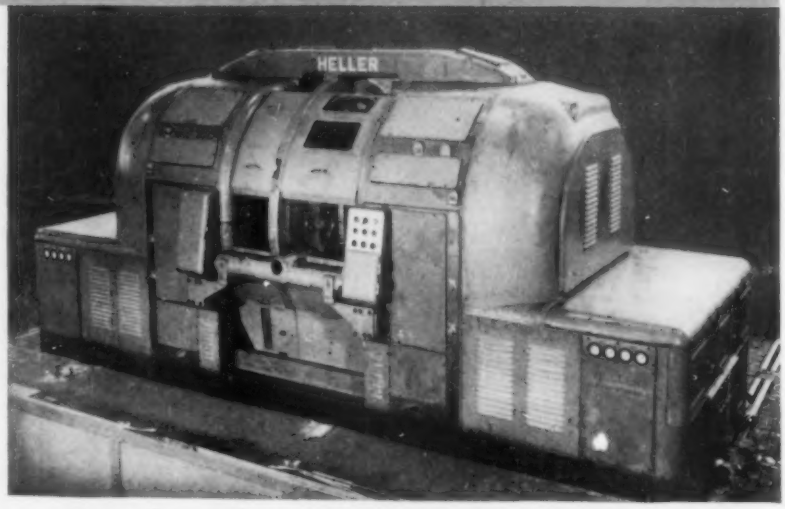


Fig. 11—Two way drum control boring machine with electrohydraulic system.

the drive clutches, and when the knob is released brakes on the transmission shaft will slow down the spindle. But if a new speed is selected when the spindle is running, pressure and release immediately shifts to the new spindle speed selected.

Automatic control of such a machine may comprise all main and auxiliary movements:

a) Speed program, corresponding to the required cutting speeds;

b) Feed program corresponding to the rates of advance:

c) Motion program for turret slides, and traverses, in high-speed and working advance;

d) Length-of-travel program, accurate delimitation of travel within tolerances on dimensions;

3) Auxiliary-motion program, as for chucking, replacing work, approach, rotation, clamping, etc.

Special Purpose Machines

Special purpose machines are used in mass and quantity production. As a rule there are only a very few machines of one type. This greatly increases the burden of the designer's responsibility. There is no opportunity for development from a prototype and no practiced operators are available. Here again, the approved standardized units of electrohydraulic controls can be of great assistance. It is therefore not surprising that the number of electrohydraulic special machines in operation is growing rapidly. Out of numerous practical examples, we will consider only one, namely that of a special milling machine for machining crank shafts.

Round milling of the crank pins on four- or six-throw shafts requires a long series of maneuvers. After insertion and hydraulic chucking of the work, there are the following steps in automatic sequence: approach both milling heads at high speed, cut to depth of crank, circular advance of work, simultaneous copying motion of carriage in accordance with changing position of crank pins, adaptation of rate of feed to chip removal, withdrawal of milling heads at end of circular advance, suboperation consisting of turning shaft to next pair of crank pins, lateral shift of milling heads for new position of crank pins, repetition of same operations in case of four-throw shaft, or twofold repetition in case of six-throw shaft, and finally return of milling heads to starting position. All of these maneuvers are carried out hydraulically, or hydromechanically. The automatic program is reliably controlled by a communications-current control station.

Automatic Multi-Station Machines

Special problems are presented by automatic multi-station machines. It makes no particular difference

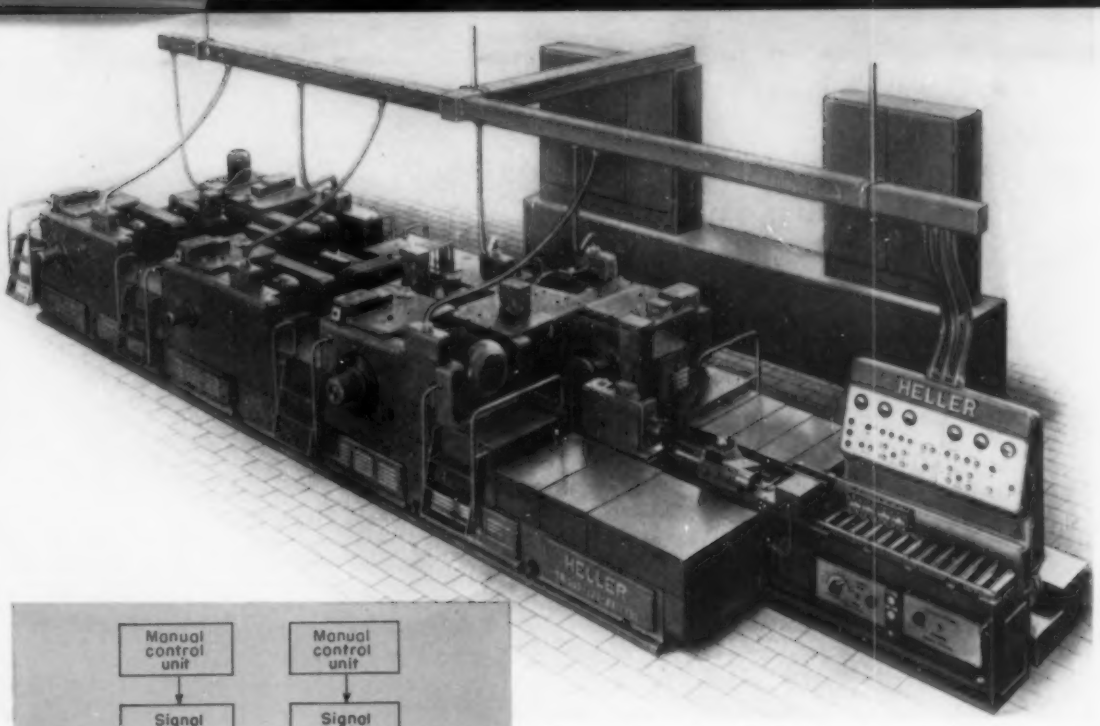


Fig. 12—Automatic production line with electrohydraulic system.

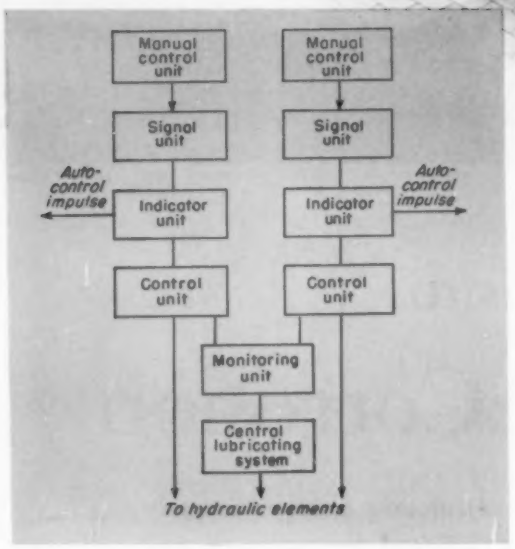


Fig. 13—Diagram of control system for production line.

whether work is conveyed from station to station circularly (revolving platform or turret machine) or in a straight line (transfer machine). In the revolving platform only one chucking and indexing operation is required for work on all stations. However, difficulties are involved in the cramped structural arrangement of individual machining units, and accommodation of feed drives and control elements. In transfer machines the difficulties involve transport, continual indexing and accurate locating, hoisting and chucking of work at separate points of operation, and varying strokes and speeds of operation.

Although the details of design for the two systems are somewhat different, these problems can all be dependably solved by proper use of electrohydraulic features. This is impressively demonstrated by the example of an automatic production line shown in Fig. 12.

The make-up of the control system may be understood from the block diagram in Fig. 13. From the right-hand and left-hand sides of the line, electrical impulses emitted by the terminal switches reach the control unit, where they are assembled, processed, stored and transmitted as final instructions to the effector units when all conditions have been satisfied. An optical monitoring unit gives a clear report of progress at the various points of operation. Finally, an additional indicating and signal unit is provided for the processes going on in the control system itself. The situation becomes more difficult when it is necessary to intervene manually, whether for adjusting purposes or because of trouble in the execution of the program. Since all of the maneuvers in the line are interlocked, it is not always obvious why a manual instruction should fail to be carried out. For this reason the central operation unit contains a relay to ascertain where the trouble is and by blinking the signal light in the proper push button, reports when a maneuver is missing.

Retrospect and Forecast

Modern electrohydraulics has given a new impetus to the development of the production process. Increased efficiency of production machine tools is an aim of the utmost importance. Communications control techniques admit of almost unlimited combinations and variations. The many systems in actual operation have fully justified expectations and demonstrated their economy and reliability.

EDITOR'S NOTE—Last month the first part of this two part article appeared in *Product Engineering* describing the basic underlying philosophy of electrohydraulics with sample circuits and descriptions of component designs.

These control principles are at variance with the design philosophy currently popular in the U. S. as exhibited in the Machine Tool Show last September. A review of some of the design features of these machine tools may be found in the November issue of *Product Engineering*, page 129, under the title "Selected Designs of Machine Elements."

Fig 1—Section through burst tube wall showing effect of stress corrosion

R. D. Barer, Pacific Naval Lab., B. C., Canada.

Resistance of Materials to Mechanical Corrosion

A brief review of the causes of stress-corrosion, corrosion fatigue, impingement, erosion, and fretting, followed by guides to the choice of the most resistant materials, and remedies possible in design.

RUSSELL W. HENKE

Chief Mechanical Engineer, Research & Development Div., Badger Meter Mfg. Co., Milwaukee, Wis.

CORROSION MAY BE DEFINED AS the "degradation of a material, with resultant reduction in usefulness, due to chemical, mechanical, or electrochemical actions, or a combination of these actions."

Commonly recognized mechanical corrosive actions are: cavitation, stress-corrosion cracking, corrosion fatigue, impingement corrosion, erosion and fretting. They are termed mechanical because they are associated with a mechanical attack on the material, though a chemical or electrochemical reaction is usually necessary to initiate or maintain the corrosive attack.

Except for cavitation, which was covered by a previous article in this series (see Editor's Note at the end of this article), each of the mechanical types of corrosion will be discussed in terms of causes, possible remedies, and resistance of most common materials to attack.

Stress-Corrosion Cracking

Stress-corrosion cracking is the result of combined electrochemical corrosion and a static stress. A part which was designed for a safe stress level may have stress concentrations on its surface produced by electrochemical corrosion. If actual stresses are raised above the yield strength of the material, failure results as shown in Fig. 1. This type of mechanical corrosion occurs only when the surface is under tensile stress just below the yield strength of the material.

Stress may come from an applied load, as in a structural or machine member, or it may be an internal stress due to working or treatment of the material. Stress from external loads are easily calculated by the designer. Inter-

STRESS CORROSION

Environment is critical in producing stress-corrosion cracking. The following is a brief outline of the metal-environment picture.

COPPER BASE ALLOYS

Brass: The brasses, alloys of copper and zinc, appear to be particularly sensitive to ammonia atmospheres. There is some evidence that CO_2 also affects this alloy. Investigations have shown that with zinc content below 6 per cent no stress-corrosion cracking occurs. Susceptibility to S-C cracking is also related to grain size, the larger the grains the more probable cracking becomes. The classic example in the bronze alloys is the season cracking of cartridge brass. The same general tendencies, with regard to grain size, have also been observed in Muntz metal and Naval Brass.

The most successful cure for S-C cracking in brass has been a low temperature anneal, which seems to serve as a stress relief treatment.

Bronze: Bronzes, on the whole, have greater resistance to stress-corrosion cracking than the brasses. As indicated above, this phenomenon is tied in with zinc content, and the bronzes having little or no zinc are more resistant.

Copper-Silicon Alloys: The lower silicon content (about 1.5 per cent) alloys appear to have greater resistance to stress-corrosion cracking than the higher (3 per cent silicon) alloys. Both are less susceptible than brass. The copper-silicon alloys are useful as a high strength, corrosion resistant material.

Copper-Nickel Alloys: The 30 per cent nickel—70 per cent copper alloy is most commonly used and has excellent resistance to stress-corrosion cracking. Only the contention that all metal systems are ultimately subject to this attack prevents making the statement that 30-70 Cu-Ni is entirely immune to it. 30-70 is also excellent in its resistance to impingement corrosion.

ALUMINUM ALLOYS

Pure Aluminum: Commercially pure aluminum is resistant to stress-corrosion cracking to a high degree.

Aluminum-Zinc: Aluminum-zinc alloys with 12 per cent or more of zinc content are very susceptible to S-C cracking, as are aluminum-magnesium alloys with magnesium content over 6 per cent. The susceptibility parallels that of the brasses wherein an increase in the alloying metal goes hand in hand with an increase in susceptibility to this form of attack.

IRON:

The varied forms and compositions of ferrous materials make it impractical to attempt a discussion of them individually. Iron is subject to stress-corrosion cracking. One of the most common forms of it is the familiar caustic embrittlement of steel in boilers. Caustic embrittlement takes place in the presence of sodium hydroxide and high stress levels. The presence of silicate in the boiler water greatly accelerates caustic-embrittlement attack.

Iron and steel are subject to S-C cracking in nitrate solutions. Dilute nitric acid is also known to induce this type of failure.

STAINLESS-STEEL:

The various stainless steel compositions will behave differently under similar conditions. They are not "stainless" nor are they corrosion resistant under all conditions. Certain acid chlorides induce stress-corrosion cracking in stainless, although as a class they are quite resistant to this type of failure.

nal stresses or residual stresses are less obvious and may be overlooked. These stresses may be:

1. Produced by non-uniform deformation during cold working.
2. Due to unequal cooling from high temperature.
3. Induced when a material is deformed.
4. Resulting from press or shrink fits.
5. Set up in rivets, bolts, pins, etc.
6. Induced when the surface of a material is stamped or embossed.
7. Set up by metallurgical phase changes involving volume changes.
8. Induced at welded joints.

Environment is influential in stress-corrosion cracking. For some metals certain environments will cause cracking while other metals will not be affected. In general, an environment which produces mild surface attack and highly localized attack is most conducive to stress-corrosion cracking. Stress is always required and many environments which cause stress-corrosion cracking barely attack an unstressed material.

Stress-corrosion seems to be the result of intergranular attack which is the preferential degradation of the grain boundary areas in metals. In many alloys, precipitation of one constituent takes place in the grain boundaries when heat treated or age hardened. The net result is a heterogeneous structure in which the grain boundaries are rich in one constituent while the rest of the grains are starved in this constituent. The grain boundaries are anodic to the grains proper and a galvanic cell action results in the "eating away" of the grain boundary areas.

This is one of the reasons that stainless steel is solution heat treated after fabrication by welding. It is necessary to return the carbides, which precipitated during welding, to solution. Otherwise, intergranular attack takes place in a corrosive atmosphere.

Typical manifestation of a stress-corrosion failure is a crack much like those associated with fatigue failure of a material in a non-corrosive environment. Indeed, it is now thought that many of the reported fatigue failures were actually unrecognized stress-corrosion failures.

Stress-corrosion may be controlled by altering the environment, the material, or the stress level within the material. Obviously economic factors involving the ex-

IMPINGEMENT and EROSION

Since corrosion by impingement or erosion is due in part to the removal of protective corrosion films, any alloy which forms a tenacious film or any substance (inhibitor) which tends to make the film more stable would seem to increase the resistance to this form of attack.

Brasses: Copper-zinc alloys have poor resistance to impingement or erosion attack.

Bronze: The high tin bronzes exhibit much greater resistance to this type of corrosion than do the brasses.

Arsenical Aluminum Brass shows good resistance, as does 70-30 Copper-Nickel containing iron.

Aluminum Brasses and Bronzes have satisfactory resistance to impingement and erosion attack.

Iron: At low velocities, in water, iron may actually be protected by the additional supply of oxygen which is available to form protective coatings. As the velocity increases to higher levels, iron exhibits the usual susceptibility to erosion or impingement attack because of breakdown of the film.

Magnesium: Little data is available. It is suspected that magnesium would be affected by this form of attack, but that the velocities involved would have to be quite high.

Aluminum: It is known that velocities up to 30 fps have little effect on the corrosion of aluminum in neutral solutions. However, as the velocity increases the pH range which can be tolerated without inducing erosive attack decreases. (*Corrosion Handbook*, Uhlig, John Wiley & Sons, Inc., p. 47)

CORROSION FATIGUE

The following generalizations have been drawn from the *Corrosion Handbook*, by H. H. Uhlig, John Wiley & Sons, Inc., page 583.

1. There is no relation between corrosion fatigue limit and tensile strength.
2. In carbon steels, there is no effect attributable to carbon content.
3. Medium alloy steels have only slightly higher corrosion fatigue limits than carbon steels.
4. Heat treatment does not improve corrosion fatigue limits.
5. Corrosion resistant steels have higher corrosion fatigue limits than other steels. Chromium is more effective than nickel as an alloying element.
6. Corrosion fatigue limits of all steels are lower in salt water than in fresh water.
7. Resistance to corrosion fatigue depends largely on general corrosion resistance.

pected or desired life of the part, its replacement cost, and the danger in the event of failure will guide the designer.

Corrosion Fatigue

Corrosion fatigue has been described as the reduction in apparent endurance limit due to the combined action of electrochemical corrosion and a cyclic stress. The role of corrosion, as in stress-corrosion cracking, is that of stress raiser. A surface discontinuity creates a stress concentration which raises the stress above the yield point.

The role of cyclic stress is the same as in any fatigue situation. Repeated cycles of tensile stress serve to open a crack and keep it progressing through the member at each successive application of the load, as shown in Fig. 2. The crack propagates at a greater rate than it would in the presence of cyclic stress alone. It is generally thought that the cyclic stress keeps breaking down the protective films, particularly oxides, which normally form on the surfaces of metals. Since the films no longer inhibit further corrosion, deep penetration is likely.

While the failure in stress-corrosion cracking tends to be intergranular (grain boundary), that associated with corrosion fatigue is by transcrystalline fracture. Investigations have shown that preferential corrosion along slip planes is the cause of corrosion fatigue failure. Since slip is a consequence of cold working of metal, these metals are highly susceptible to corrosion fatigue.

Corrosion fatigue forms a pitted surface with many small cracks at the bottom of each pit. This serves to differentiate this form of corrosive attack from a mechanical fatigue failure, in which there is normally only one crack. The cracks run perpendicular to the direction of application of the stress.

Remedies for corrosion fatigue are the same as those mentioned above for stress corrosion.

Impingement and Erosion Corrosion

These two classes of corrosion are closely related and considered to be different degrees of the same basic phenomenon. As shown in Fig. 3, the attack is the result of the abrasive action of a fluid striking the surface of the material at high volocity.

Accepted definitions as given by Speller in "Corrosion, Causes and Prevention," (McGraw-Hill) are:

"Impingement Corrosion is degradation of the material associated with turbulent flow of a liquid."

"Erosion is the destruction of a material by the abrasive action of a liquid or gas."

It is generally accepted theory that the velocity distribution in a confined duct in which fluid is undergoing laminar flow is parabolic and fluid velocity at the duct walls is zero. In turbulent flow, however, the fluid is "boiling" and swirling through the duct. Here the relative velocity between duct wall and fluid may be high.

It is the relatively high velocities associated with turbulent flow which give rise to impingement corrosion. Impact of liquid on metal is not sufficient to remove virgin material. Chemical or electrochemical corrosion takes place first and then the less adherent corrosion products are washed away by the action of the liquid, re-exposing new material to further corrosive degradation.

Erosion is involved where the velocities are very high—high enough, perhaps, to even cause mechanical erosion of the metal, though it is not certain that this is the cause. It is more likely that as before, intermediate corrosion product is formed and removed at a high rate.

Remedies at the disposal of the designer attempting to eliminate or reduce impingement or erosion are to reduce the velocity of the fluid or to select a material which is resistant to this form of attack under the existing conditions. Reducing turbulence and the elimination of fine, suspended material or small air bubbles will also aid greatly in inhibiting this form of corrosive attack.

Fretting Corrosion

Fretting corrosion is surface damage that occurs when two solid surfaces are in vibrating contact under high unit loads. The classic example is the degradation occurring

FRETTING — Resistance of Some Typical Materials

POOR	AVERAGE	GOOD
Aluminum on Cast Iron	Cast Iron on Cast Iron	Laminated Plastic on Gold Plate
Aluminum on Stainless Steel	Copper on Cast Iron	Hard Tool Steel on Tool Steel
Magnesium on Cast Iron	Brass on Cast Iron	Cold Rolled Steel on Cold Rolled Steel
Cast Iron on Chrome Plate	Zinc on Cast Iron	Cast Iron on Cast Iron with Prosphate Coating
Laminated Plastic on Cast Iron	Cast Iron on Silver Plate	Cast Iron on Cast Iron with Coating of Rubber Cement
Bakelite on Cast Iron	Cast Iron on Copper Plate	Cast Iron on Cast Iron with Coating of Tungsten Sulfide
Hard Tool Steel on Stainless	Cast Iron on Amalgamated Copper Plate	Cast Iron on Cast Iron with Molykote Lubricant
Chrome Plate on Chrome Plate	Cast Iron on Cast Iron with Rough Surface	Cast Iron on Stainless with Molykote Lubricant
Cast Iron on Tin Plate	Magnesium on Copper Plate	
Cast Iron on Cast Iron with Coating of Shellac	Zirconium on Zirconium	
Gold Plate on Gold Plate		

between the surface of a ball or roller bearing race and the shaft on which it is pressed.

Fretting corrosion is initiated by mechanical wear produced by a relative motion between the two surfaces forced together under high load. This wear might be likened to a galling of the two surfaces, which is usually accompanied by a corrosive action due to the operating environment. The softer corrosion products accelerate the rate of mechanical attack, acting like a grinding medium between the two vibrating surfaces. Failure is characterized by a discoloration of the surface and deep pits in the attacked area. Close tolerance fits are destroyed and stress raisers are introduced at the highly loaded points where they can be least tolerated. Fatigue failure may result when the attack is uninhibited.

Fretting corrosion is responsible for failure of many mechanical members, such as: connecting rods, splined shafts, couplings, axles, steering knuckles, rivets, etc.

Fretting corrosion may be controlled by reducing the relative motion between the two surfaces. Roughened surfaces tend to increase friction and minimize slippage. Another method is adequate lubrication of the contacting surfaces to completely exclude the corrosive atmosphere.

EDITOR'S NOTE—In the September 1955 issue of *Product Engineering*, page 173, Dr. L. A. Petermann described the use of ultrasonics to induce cavitation near the surface of various materials. Test results are included in this article entitled "Cavitation in Ultrasonic Equipment."

In June 1952 on page 189, "New Data on Stress-Corrosion" summarized a National Bureau of Standards' investigation and included a table of electrochemical potentials as influenced by stress.

"Corrosion Factors in Design and Lubrication," in October 1952 page 142, were compiled by the staff from information from International Nickel offering design suggestions for increasing corrosive resistance. The effects of velocity, galvanic action, shelter from atmosphere, and lubricants are discussed.

"Corrosion Resistance of Typical Laminated Metals," in May 1951 page 211, was a one-page table showing resistance to heat, wear and selected corrosive materials and compounds.

In July 1951, two associated articles appeared. The first, "Corrosive Factors in Design," by F. M. Reinhart, on page 101, discussed such factors as acidity, oxidizing agents, surface films, temperature, atmosphere and sea water on galvanic, concentration cell, stress and fretting corrosion. On page 158, "Recommended Design Details to Reduce Corrosion" listed sixteen specific methods for corrosion control.

Fig. 2 *Chase Brass & Copper Co.*

Fig. 2—Corrosion fatigue cracks in an Admiralty Brass tube used in an oil refinery.

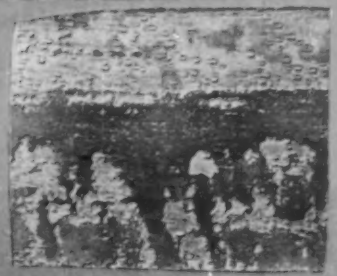
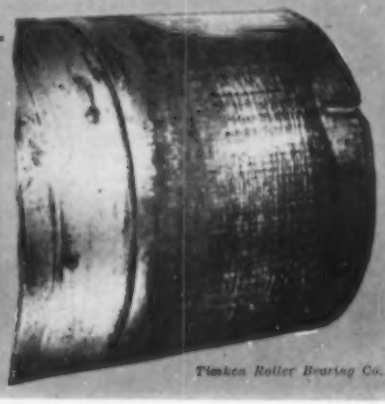


Fig. 3 *Chase Brass & Copper Co.*

Fig. 3—Impingement attack on a section of Admiralty Brass tube which has been flattened for this protograph.

Fig. 4



Timken Roller Bearing Co.

Fig. 4—Fretting corrosion on the end of a shaft which was in a press fit.

Fractional Horsepower Motors

SIDNEY DAVIS, SERVOMECHANISMS, INC.

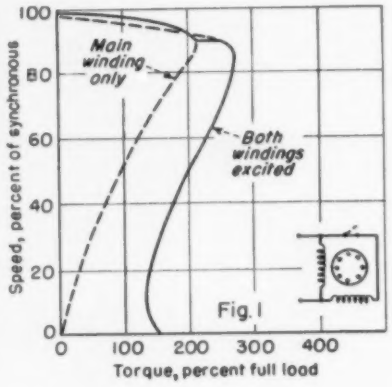


FIG. 1—SPLIT-PHASE. For constant-speed operations with moderate torque requirements: washing machines, oil burners, blowers, light machine tools. Lower in cost than capacitor-start motors. Range: 1/20-1/3 hp.

FIG. 2—CAPACITOR-START. General-purpose motor suitable for heavy-duty applications requiring high locked-rotor torque and good running efficiency. Hoist service, fans, refrigerators, compressors, stokers. Range: $\frac{1}{4}$-$\frac{3}{4}$ hp.

FIG. 3—(A) PERMANENT-SPLIT CAPACITOR. Constant-speed motor for special-purpose applications such as: heaters, fans, blowers. Other speeds can be obtained by switch arrangement (B), or by using autotransformers. Range: 1/20-$\frac{1}{4}$ hp.

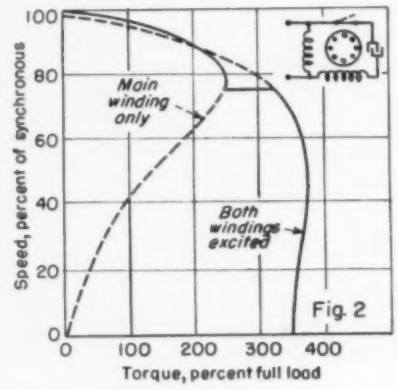
FIG. 4—REPULSION-START INDUCTION. High starting torque suitable for belt and chain drives in pumps, compressors, refrigerators. Becoming replaced by capacitor-start motor. Induction motor characteristics under load. Range: $\frac{1}{4}$-$\frac{1}{2}$ hp.

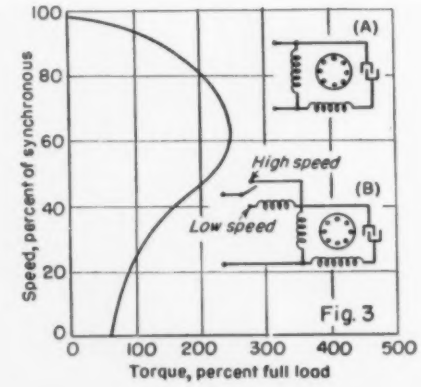
FIG. 5—SHADED POLE. Generally under 1/20 hp. Least expensive of a-c motors but has low starting torque and efficiency. Fans, small blowers, unit heaters. Range: 1/2000-$\frac{1}{4}$ hp.

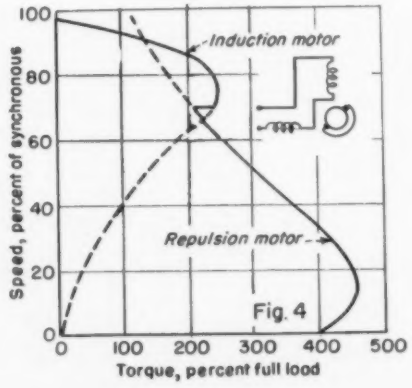
FIG. 6—SYNCHRONOUS RELUCTANCE. Constant speed regardless of load and voltage fluctuations. Teleprinters, sound recording, clocks. Synchronous hysteresis motors can synchronize high inertias such as in gyro drives. Range: 1/3000-1/3 hp.

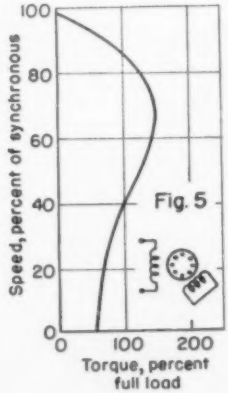
FIG. 7—UNIVERSAL. Popular because of high starting torque, high speed, small size and weight for given output. Speed varies sharply with load. Portable tools, vacuum cleaners, mixers, sewing machines. Range: entire fractional hp.

FIG. 8—UNIVERSAL GOVERNOR-CONTROLLED. Speed is independent of voltage. Governor can be single speed or adjusted even while running. Business machines, typewriters, food mixers, movie projectors. Range: 1/50-$\frac{1}{4}$ hp.









Selection charts, schematic diagrams, speed-torque curves and typical applications for 12 types of fractional and subfractional motors.

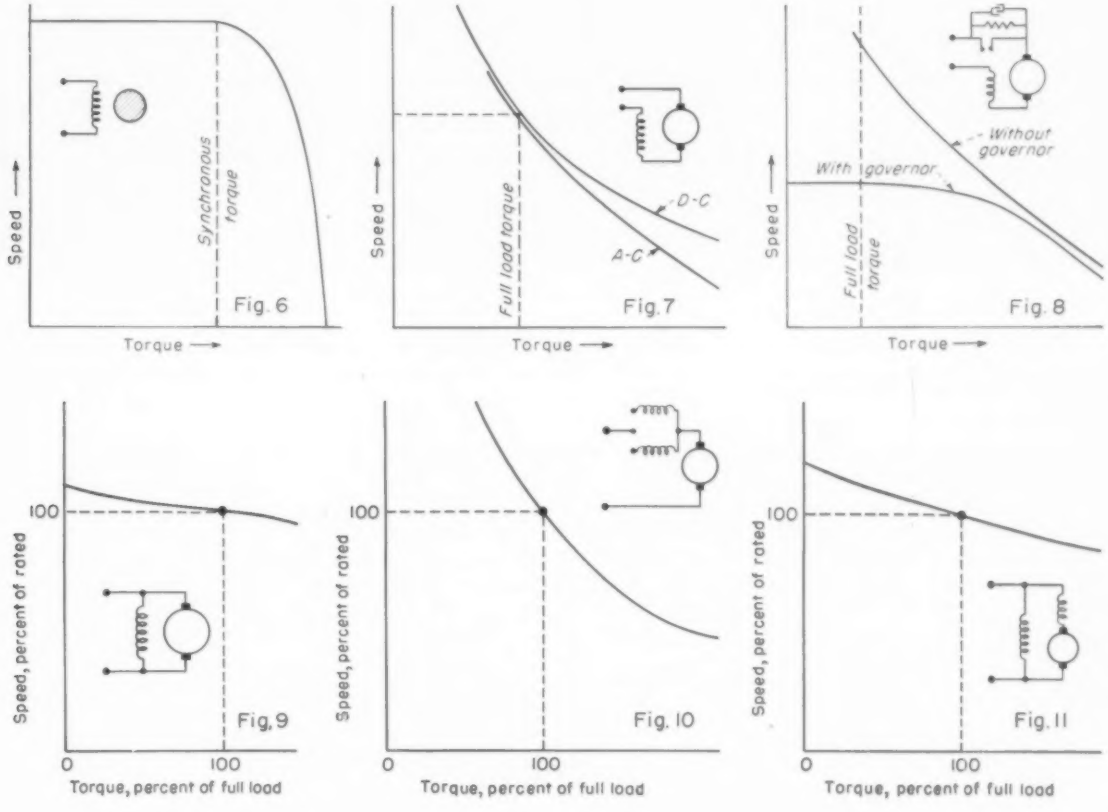


FIG. 9—SHUNT—General-purpose motor used where a-c is not available or where variable speed is desirable. Operates efficiently at many speeds by adjusting field rheostat. Applications similar to capacitor-start motor. Range: 1/20-$\frac{1}{4}$ hp.

FIG. 10—SPLIT-SERIES FIELD. Used for ease of reversibility; requires only a single-pole double-throw switch for reversing. Races with light load and full voltage. Applications similar to universal motor. Range: 1/25-1/30 hp.

FIG. 11—COMPOUND. Speed and torque characteristics between shunt and series motor depending upon degree of compounding. Applications similar to capacitor-start motor. Range: 1/100-$\frac{1}{4}$ hp.

SELECTION CHART

High operating efficiency—Figs. 3, 4, 9, 10, 11
Constant speed—Figs. 1, 2, 3, 5, 6, 8, 9, 11
Synchronous—Fig. 6
Varying speed—Figs. 7, 10
Adjustable speed—Fig. 9
Good starting torque—Figs. 2, 4, 7, 8, 10
A-c only—Figs. 1, 2, 3, 4, 5, 6
D-c only—Figs. 9, 10, 11
Both a-c, d-c—Figs. 7, 8
Reversible—Figs. 3, 6, 9, 10, 11
Reversible from rest—Figs. 1, 2, 4
Minimum cost—Figs. 1, 5, 6
Medium cost—Figs. 2, 3, 7, 9, 10

Strain-Gage Bridge Sensitivity Control

How an adjustable resistance in series with the bridge voltage supply maintains, increases, or decreases instrument sensitivity, permits use of gages with gage factors outside limits of instrument adjustment dial, simplifies calibration procedures, and corrects for system errors. First of two articles on applications of resistance control for sensitivity of strain-gage bridges.

PETER K. STEIN

Instructor, Mechanical Engineering, Massachusetts Institute of Technology

RESISTANCES IN SERIES with the supply voltage to a Wheatstone bridge arise from three primary sources: (1) Extraneous, parasitic quantities such as lead resistance; (2) resistance inherent in the bridge voltage supply such as the internal resistance of a dry cell or impedance of an oscillator; such internal impedances, for purposes of analysis, may be considered as being in series with the voltage sources; and (3) resistance deliberately introduced to produce a specific change in bridge characteristics.

Referring to the nomenclature and electrical bridge diagram of Fig. 1 it is possible to write:

$$v = V \frac{R_t}{R_t + R_s} \tag{1}$$

and

$$R_t = \frac{(R_1 + R_2)(R_3 + R_4)}{(R_1 + R_2 + R_3 + R_4)} \tag{2}$$

Then, provided that the input impedance of the measuring system placed across the bridge output terminals is high compared to R_t.

$$E = v \frac{(R_2 R_4 - R_1 R_3)}{(R_1 + R_2)(R_3 + R_4)} \tag{3}$$

$$E = V \left(\frac{R_t}{R_t + R_s} \right) \left[\frac{R_2 R_4 - R_1 R_3}{(R_1 + R_2)(R_3 + R_4)} \right] \tag{4}$$

To determine the effect on E of small changes in R_t the following equation is analyzed.

$$dE = \left(\frac{\delta E}{\delta R_1} \right) d R_1 + \left(\frac{\delta E}{\delta R_2} \right) d R_2 + \left(\frac{\delta E}{\delta R_3} \right) d R_3 + \left(\frac{\delta E}{\delta R_4} \right) d R_4 \tag{5}$$

In neglecting non-linearity effects a small error is made which, in general, is negligible. The equation for the error and design charts for its quick determination in any specific case may be found in "Strain Gage Techniques," W. M. Murray and P. K. Stein, M. I. T., 1955. Subsequent substitution in the results of Eq (5) of Δ quantities for differential forms will yield a good approximation to Eq (5).

$$\Delta E = V \frac{R_1 R_3}{(R_1 + R_2)(R_3 + R_4)} \left[\frac{R_t}{(R_s + R_t)} \right] \left[\frac{\Delta R_1}{R_1} + \frac{\Delta R_3}{R_3} - \left(\frac{\Delta R_2}{R_2} + \frac{\Delta R_4}{R_4} \right) \frac{R_2 R_4}{R_1 R_3} \right] + V \frac{R_s}{(R_s + R_t)^2} \left[\frac{R_2 R_4 - R_1 R_3}{(R_1 + R_2)(R_3 + R_4)} \right] \left[\frac{1}{1 + \left(\frac{R_3 + R_4}{R_1 + R_2} \right)^2} \right] \left[\Delta R_2 + \Delta R_4 + \left(\frac{R_3 + R_4}{R_1 + R_2} \right)^2 (\Delta R_1 + \Delta R_2) \right] \tag{6}$$

For an initially balanced bridge this reduces to:

$$\Delta E \Big|_{E=o} = V \frac{R_1 R_2}{(R_1 + R_2)^2} \left[\frac{R_t}{R_s + R_t} \right] \left[\frac{\Delta R_1}{R_1} - \frac{\Delta R_2}{R_2} + \frac{\Delta R_3}{R_3} - \frac{\Delta R_4}{R_4} \right] \tag{7}$$

For the particular case of an equal arm bridge where $R_1 = R_2 = R_3 = R_4 = R_o$,

$$\Delta E \Big|_{E=o} = \frac{V}{4} \left(\frac{1}{1 + \frac{R_s}{R_o}} \right) \left(\frac{\Delta R_1}{R_1} - \frac{\Delta R_2}{R_2} + \frac{\Delta R_3}{R_3} - \frac{\Delta R_4}{R_4} \right) \tag{8}$$

NOMENCLATURE

R_1, R_2, R_3, R_4 — Resistances of the arms of a Wheatstone bridge. They may or may not be strain gages; when strain gages, subscripts denote gage number.

R_a — Value of R_1, R_2, R_3 or R_4 when all are equal to each other.

R_t — Effective resistance of bridge alone, as measured in series with voltage supply and resistance R_s.

R_s — Resistance composed of R_a plus R_x in series with supply voltage, not including bridge resistance.

R_x — That part of R_s added deliberately by adjustment of variable resistor.

R_r — That part of R_s inherent in voltage supply and lead resistance to bridge.

V — Total bridge supply voltage.

v — Voltage appearing across bridge.

E — Steady output from bridge.

ΔE — Incremental output resulting from varying one of bridge resistances.

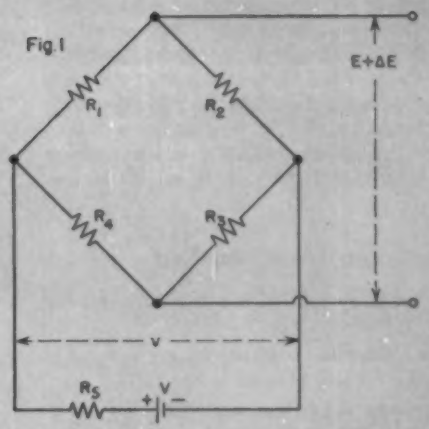


Fig. 1—Electrical diagram of Wheatstone bridge, voltage supply, and series resistance.

It may be seen, therefore, that the existence of a series resistance, in the simplest case, has introduced the factor

$$n = \frac{1}{1 + (R_s/R_a)}$$

into the relationship expressing strain-induced output voltage from the bridge as a function of strain. The sensitivity of the bridge has been reduced by a factor n, so that actual sensitivity is equal to n times the maximum sensitivity, where sensitivity is maximum when R_s is equal to zero.

For a true null-balance bridge system, a reduction in sensitivity due to a series resistance does not occur because the output from the system is not dependent on the supply voltage or on any resistance in series with it. There are, however, commercially available measuring instruments which nominally operate on the null-balance principle but which actually obtain the null by opposing the transducer-bridge output with an artificially produced reference-bridge output. In this case a zero output results from the overall system without necessarily having zero output from the transducer bridge. In such cases, the Baldwin Strain Indicator for example, this desensitization procedure may be used for bridge sensitivity control.

Gage-Factor Adjustment Dial for Unbalance Measuring System

On commercially available strain-indicating instruments for use with resistance strain gages, the gage-factor adjustment dial controls a variable resistance placed in series with the bridge voltage supply so as to regulate the sensitivity of the instrument. For high gage-factor gages the sensitivity is decreased by increasing series resistance R_x, and vice versa for low gage-factor gages in such a manner as to maintain the calibration sensitivity of the output dial from the instrument. In this manner the gage-factor adjustment dial permits maintenance of calibration sensitivity for gages of different gage factors allowing calibration of the output dial of the instrument directly in terms of strain.

The gage factor is a sensitivity factor which relates per cent resistance change $\Delta R/R$ in a resistance strain gage to the strain ϵ which produces it. Since all strain gage circuits respond either to ΔR or to $\Delta R/R$, the gage factor (GF) may be considered to be a sensitivity control on the electrical circuit containing the gage such that, where ϵ is the indicated strain on the output dial,

$$\epsilon = \frac{1}{(GF)} \left(\frac{\Delta R}{R} \right) \tag{10}$$

When a strain-gage reading is transposed from per-cent resistance change of the gage into the value of actual strain in the specimen to which the gage is attached, the most commonly used approximation is that in Eq (10).

In order to read actual strain on the instrument output dial in instruments with a gage-factor adjustment dial, it is necessary to adjust the dial to the setting specified by the strain-gage manufacturer for the particular gage used. For a given strain existing in the specimen, there is a unique value of $\Delta R/R$ for the strain gage. Depending on the setting of the gage-factor dial, almost any indicated strain may be obtained, but indicated strain equals true strain only if the manufacturer's recommended gage factor is set on the dial. Expressed mathematically:

$$\frac{\Delta R}{R} = (GF)_m \quad (\epsilon_t) = (GF)_u \quad (\epsilon_i) \tag{11}$$

$$\epsilon_t = \frac{(GF)_u}{(GF)_m} \quad (\epsilon_i) \tag{12}$$

Where:

$(GF)_m$ = Manufacturer's recommended gage factor
ϵ_t = True strain reading obtained when $(GF)_m$ is set on dial
$(GF)_u$ = Gage factor used as set on the dial
ϵ_i = Indicated strain obtained when $(GF)_u$ is set on dial

For a true strain in the specimen, it is therefore possible

to obtain numerous indicated strain readings on the instrument, depending on the gage-factor settings used on the dial. For any given mechanical strain beneath a gage, the product of indicated strain times gage-factor setting used is a constant and is independent of the gage-factor setting, but is equal to the $\Delta R/R$ caused in the strain gage by the mechanical strain. So long as the manufacturer's gage-factor is known, indicated strain readings obtained at any other gage factor may be related to true strain through Eq (12).

Gage-Factor Adjustment Dial

There are six principal applications of the gage-factor dial:

1) **To maintain calibration sensitivity** for gages of different gage factors, the primary purpose of the dial.

2) **To increase measuring system sensitivity.** For example, if a strain gage has a gage factor of 2.20, sensitivity of the system may be increased 20 per cent by setting the gage-factor adjustment dial to 1.83 and interpreting the readings obtained using Eq (12).

3) **To decrease measuring-system sensitivity.** For rapid instrument balancing, if it is desired to remain within one particular range of the instrument (avoiding the use of range-extension switches); it may be possible to do so by manipulating the gage-factor control.

4) **To accommodate gages with gage factors outside the range of the dial.** If the gage factor of the gage lies outside the limits of the instrument adjustment dial, the relationship expressed in Eq (12) may be used.

5) **To simplify calibration procedures.** Strain gages are frequently used in transducers designed to measure force, torque, pressure, etc. If the calibration factor for such a device is, for example, 930 micro-in. per in. per unit of measured physical quantity when the recommended gage factor is set on the dial, a round figure of 1000 may be obtained by setting the dial at 0.93 times the recommended gage factor. Indicated strain no longer equals true strain, but the transducer calibration constant is a round figure.

6) **To correct for system errors.** Whenever a correction factor F exists to account for attenuations in a strain-measuring system, two methods of error correction are possible. First, the manufacturer's gage factor can be set on the gage factor dial (or used in the computations) and the indicated strain is treated as follows:

$$\text{True strain} = (F) \times (\text{Indicated strain})$$

Second, using a gage factor on the dial, of $1/F$ times the manufacturer's gage factor the strain indicated by the measuring system will then be equal to true strain. In this manner the gage-factor adjustment dial may be used to account for any system errors, and the indicated strain readings from the instrument may be regarded as true strain values.

Design of a Gage-Factor Adjustment Dial

Maintaining the nomenclature and symbols set up previously, let:

R_1 be a strain gage
$(GF)_1$ be the gage factor of gage R_1
ϵ_1 be the strain to which R_1 is subjected
ΔR_1 be the strain-induced resistance change in R_1
$R_o = R_1 = R_2 = R_3 = R_4$

R_2, R_3, R_4 are "dummy" gages or fixed resistors and are not active in terms of strain. Sensitivity S_o for a Wheatstone bridge formed by these resistors can be defined as:

$$S_o = \frac{\Delta E}{V} \cdot \frac{1}{\epsilon_1}$$

Then, since by definition:

$$\epsilon_1 = \frac{\Delta R_1}{R_1} \cdot \frac{1}{(GF)_1} \tag{15}$$

and since the bridge is initially balanced, using Eq (8),

$$S_o = \frac{1}{4}\,(GF)_1 \left(\frac{R_o}{R_{s1} + R_o} \right) \tag{16}$$

Since it is desired to maintain constant sensitivity by adjusting R_s for gage factors other than $(GF)_1$,

$$S_o = \frac{(GF)_1}{4} \cdot \frac{R_o}{R_{s1} + R_o} = \frac{(GF)_2}{4} \cdot \frac{R_o}{R_{s2} + R_o} \tag{17}$$

where $(GF)_2$ is a gage factor other than $(GF)_1$, and R_{s2} is the value of R_s required to maintain calibration sensitivity. But R_{s1} and R_{s2} are each composed of R_v, the unavoidable internal voltage-source and lead resistance, and R_{a1} and R_{a2} the artificially added resistances.

So $R_{s1} = R_v + R_{a1}$ (18)

and $R_{s2} = R_v + R_{a2}$ (19)

then $$\frac{R_{a2}}{R_o} = \frac{(GF)_2}{4\,S_o} - \left(1 + \frac{R_v}{R_o}\right) \tag{20}$$

or $$\frac{R_{a2}}{R_o} = \frac{(GF)_2}{(GF)_1}\left[\frac{R_{a1} + R_v}{R_o} + 1\right] - \left(1 + \frac{R_v}{R_o}\right) \tag{21}$$

where $$S_o = \frac{\Delta E}{V\,(\epsilon_1)} = \frac{1}{4} \cdot (GF)_1 \left[\frac{1}{1 + \left(\frac{R_{a1} + R_v}{R_o} \right)} \right] \tag{22}$$

Eq (20) represents a straight-line relationship between $(GF)_2$ and (R_{a2}/R_o) for any given value of R_v and S_o.

EXAMPLE:

For $R_v/R_o = 0.05$ and for a value of $S_o = 0.4$ mv/v/1000/micro-in./in. with a value of $R_s/R_o = \frac{1}{4}$ maximum, determine the range of the resulting gage factor dial when used with 120-ohm gages. Minimum value of R_s is zero.

From Eq (18),

$$(GF)_2 = 4\,S_o \left[1 + \frac{R_{a2}}{R_o} + \frac{R_v}{R_o} \right] = 2.313 \text{ maximum}$$

From Eq (19),

$$(GF)_1 = \frac{(GF)_2 \left[1 + \frac{R_v}{R_o} \right]}{1 + \frac{R_{a2}}{R_o} + \frac{R_v}{R_o}} = 1.768 \text{ minimum}$$

Any calibration of the R_s dial in terms of equivalent gage factor will hold only for gages of resistance R_o and will no longer be meaningful when other bridge-arm-resistance values are used. In most cases where a carrier system is used, the internal impedance of the carrier oscillator will vary with the effective load across its terminals. This load may be approximated as $(R_o + R_s)$ in this case. Hence the constants in Eq (8) may be varied.

A specified value of R_a when used may result in a change of R_t which then calls for a different value of R_a to simulate the same gage factor.

Gage-Factor Control. If a variable resistance R_a is inserted in series with the supply voltage to the bridge, and if the resistance dial is calibrated as follows:

$$R_a = \left(\frac{R_o}{4\,S_o}\right)(GF)_a - (R_o + R_v) \tag{23}$$

or

$$(GF)_a = \left(\frac{R_a}{R_o}\right)(4\,S_o) + \left(\frac{4\,S_o}{R_o}\right)(R_o + R_v) \tag{24}$$

where $(GF)_a$ is the gage factor read on the resistance dial, then a gage factor control has been incorporated into the bridge.

This condition may be verified as follows: Let the output dial from the instrument be calibrated in strain directly, and let ϵ_i be the strain indicated by the instrument for any given $\Delta R/R$ in the gage. Then, from Eq (14) the relationship governing the dial markings is:

$$\epsilon_i = \frac{\Delta E}{V S_o} \tag{25}$$

But, for a single active gage of resistance R_o in the bridge:

$$\Delta E = \left(\frac{V}{4}\right)\left(\frac{\Delta R}{R_o}\right)\left(\frac{R_o}{R_o + R_a + R_v}\right) \tag{26}$$

Substituting (23) and (25) into (26)

$$\frac{\Delta R}{R} = (\epsilon_i)\,(GF)_a \tag{27}$$

independent of any other variable. Since, by definition

$$\frac{\Delta R}{R} = (\epsilon_t)\,(GF)_m \tag{28}$$

one may always set $(GF)_a = (GF)_m$ on the calibrated gage factor dial and obtain on the calibrated output dial a directly indicated value of true strain.

Compensating for Gages of Resistance R_o with a Gage Factor Outside the Range of Dial Settings. Since the gage resistance R_o is equal to the resistance for which the dial was designed, relationship (12) may be used as follows: Set any gage factor $(GF)_a$ available on the dial and obtain an indicated strain reading ϵ_i; To obtain the value of true strain ϵ_t solve for

$$\epsilon_t = \left[\frac{(GF)_a}{(GF)_m}\right]\epsilon_i \tag{12}$$

Effect of a Gage of Resistance Other Than R_o. When a gage of resistance R_i different from R_o is used in the bridge, calibration of the gage-factor dial is no longer applicable except at one point, and that point is fictitious since it lies outside the limits of the dial. In this case, from Eq (26) it may be seen that

$$\Delta E = \left(\frac{V}{4}\right)\left(\frac{\Delta R}{R_i}\right)\left(\frac{R_i}{R_a + R_i + R_v}\right) \tag{29}$$

but

$$R_a = \left(\frac{R_o}{4\,S_o}\right)(GF)_a - (R_o + R_v) \tag{23}$$

and

$$\Delta E = (V)\,(S_o)\,(\epsilon_i) \tag{25}$$

Since the physical calibration of the dial remains unchanged:

$$\frac{\Delta R}{R} = (\epsilon_i)\,(GF)_a\left[\frac{R_o}{R_i} + \left(1 - \frac{R_o}{R_i}\right)\frac{4\,S_o}{(GF)_a}\right] \tag{30}$$

This relationship deteriorates into the desired form

$$\frac{\Delta R}{R} = (\epsilon_i)\,(GF)_a$$

only when

$$(GF)_a = 4\,S_o \tag{31}$$

But Eq (31) is unattainable, because R_v, although small, is finite and positive; and from Equation (22), for $R_a = 0$, the minimum setting on the gage factor dial is

$$\text{minimum } (GF)_a = 4\,S_o\left(1 + \frac{R_v}{R_o}\right) \tag{32}$$

Hence the conditions of equation (31) cannot be fulfilled and the gage-factor dial calibrated for a gage of resistance R_o cannot be used for gages of resistance R_i different from R_o.

If the gage-factor dial is incorporated in the transducer bridge, the calibration will hold only for the gage resistance for which it was designed. To overcome this difficulty, versatile strain-measuring instruments are sometimes built on the reference-bridge principle; the gage-factor adjustment dial is incorporated into the reference-bridge circuit where it remains unaffected by the transducer resistance in the transducer bridge.

Effect of Gage-Factor Setting on Initial Zero Instrument Reading

The gage-factor control in the form of a resistance in series with a Wheatstone-bridge supply voltage is an effective bridge sensitivity control. However, if the bridge is not balanced initially, initial bridge output will depend on the setting of that series resistance. This consideration affects the zero-reading obtained, and is of importance when:

(1) The bridge is used as a null-balance system but not brought to true zero every time. Instead of true zero, a given bridge output may serve as "reference" zero which will be affected by gage-factor adjustment, thus creating fictitious strain values if not properly interpreted.

(2) In an unbalance measuring system not initially balanced exactly, adjustment of the gage-factor dial creates extraneous strain values.

(3) In a reference-bridge null-balance system where the output from the transducer bridge and the reference bridge are both non-zero, whereas their sum is zero, any adjustment of the gage-factor dial in either bridge, will vary the non-zero output from that bridge, creating erroneous strain value.

The effect of gage-factor setting on initial zero reading reverts to determination of series-resistance-variation effect on bridge output when the bridge is not balanced and this output is not zero. From Eq (4) and referring to Fig. 2,

$$E = V\left[\frac{R_2 R_4 - R_1 R_3}{(R_1 + R_2)(R_3 + R_4)}\right]\left[\frac{R_i}{R_a + R_i}\right] \tag{8}$$

Let

$$E_o = V\left[\frac{R_2 R_4 - R_1 R_3}{(R_1 + R_2)(R_3 + R_4)}\right] \quad (33)$$

which is the unbalance which would exist if $R_s = O$. Then

$$E = E_o\left(\frac{R_t}{R_s + R_t}\right) \quad (34)$$

The largest value of E_o is usually given by the tolerance limits on the gage resistances. If all four arms of the bridge are strain gages such that:

$$R_o(1 - m) < R_v < R_o(1 + m)$$

then the maximum expected value of E_o may be obtained from Eq (8), where R_s is zero and where $\Delta R/R$ equals m:

$$E_o = (V)(m)$$

From Eq (34) a curve of E as a function of R_s for various values of E_o may be obtained which appear as a family of curves shown in Fig. 2. Since R_s is proportional to (GF), the more the bridge is initially unbalanced, the greater the effect of gage-factor adjustment on indicated zero strain. Where an instrument with gage-factor adjustment dial is to be used to check the zero-stability of a strain-gage setup over long periods of time, and where the measuring instrument is used for other purposes in between stability measurements, a small difference in gage-factor setting may create a large equivalent zero shift if the transducer-bridge is not perfectly balanced. For a balanced bridge, the position of the gage-factor dial will not affect the zero-reading on the measuring instrument.

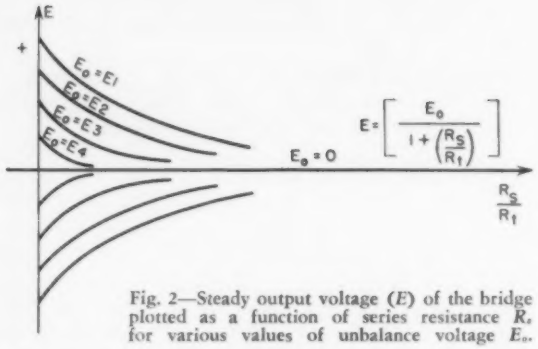


Fig. 2—Steady output voltage (E) of the bridge plotted as a function of series resistance R_s for various values of unbalance voltage E_o.

MORE COMING—The next article of this series will describe the design and use of an automatic resistance compensator for elastic-modulus temperature changes of strain-gage transducers.

Self-Fluxing Brazing Alloys for Ferrous Metals

SELF-FLUXING BRAZING ALLOYS, usually limited in application to non-ferrous metals, now are being used with ferrous materials, as a result of a recent development at the Armour Research Foundation of the Illinois Institute of Technology, Chicago 16, Ill. Key to the new brazing alloy is the addition of lithium.

For some time brazing fluxes have been replaced by reducing atmospheres, particularly in high-temperature brazing where they reduce the oxides on the base metal surfaces and prevent these surfaces from oxidizing during the brazing process. But since the reducing atmospheres reduce the metallic oxides only at these higher temperatures, they cannot be used for low temperature brazing or soldering and still produce joints of good uniformity and strength. Even in a good reducing atmosphere, stainless steel will oxidize greatly if the atmosphere has the smallest amount of water vapor. To get stronger brazed joints with stainless steel, it has been common practice to plate a thin coating

In tests with a 1 per cent lithium, 99 per cent silver alloy, it was found that lithium not only reduces the oxides loy, it was found that Lithium not only reduces the oxides on the surfaces of these steels, but also promotes wettability. Armour states that the new alloy will permit the brazing of plain carbon steels, stainless steels, cermets, and metal to porcelain without a flux or a reducing atmosphere. The tensile strength of these joints is high.

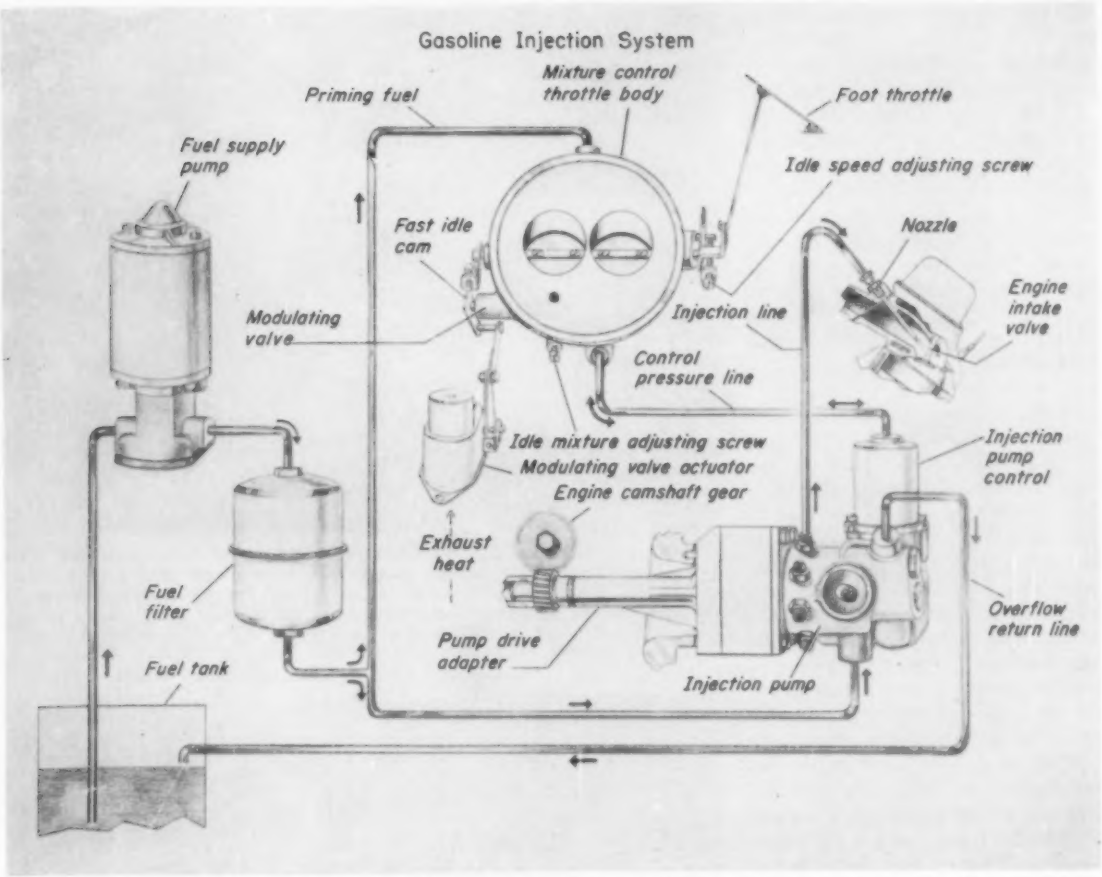
Self-fluxing copper-phosphorous and silver-copper-phosphorus alloys have been in use for some time. When used on copper, or copper rich alloys, no flux or reducing atmosphere is necessary. When brazing, the phosphorus oxidizes partly by reduction of the oxides present on the surface of the copper on which the brazing alloy flows. The fusible slag which is a result of this reaction takes the place of the flux which is normally added. However, brazing alloys containing large amounts of phosphorus cannot be used on ferrous materials, nickel or any alloys containing nickel because of the resulting brittle phosphides. Therefore, phosphorus, a strong deoxidizer, cannot be used as a deoxidizing agent for brazing steels.

Finding a suitable replacement was not a simple matter, for while it is easy to reduce iron oxides, it is much more difficult to reduce the oxides of some alloy, steels, particularly those having heavy reducible oxides on the surfaces. A few are chromium oxide, tungsten oxide, titanium oxide, and others. Thus, what was needed was a deoxidizing material having a high affinity for oxygen at practical brazing temperatures. Also, the products of the deoxidizing reactions should have a low melting point. Of importance too, is that the deoxidizer must reduce the surface tension of the molten brazing alloy so that it will promote wetting of the solid base metal by the molten self-fluxing brazing alloy.

It was found that a 1 per cent lithium—99 per cent silver solder proved best. The addition of lithium results in a complete reduction of the iron oxides on the steel-silver interface, and results in excellent wetting of the doxidizing steel surfaces. The ultimate tensile strength of type 303 stainless steel bars brazed with the 1 percent Li—99 per cent Ag alloy is 52,100 psi. The bond was sound, and had no voids.

When exposed to the air for one week and dipped in water for 24 hours, this bond did not show any signs of corrosion. On the other hand, a test strip brazed with a 2 per cent Lithium—98 per cent silver alloy had an ultimate tensile strength of 48,600 psi, had some non-metallic inclusions, and was not as corrosion resistant nor ductile.

TECHNICAL NEWS



SCHEMATIC VIEW OF THE AMERICAN BOSCH GASOLINE INJECTION SYSTEM, designed to replace the conventional carburetor system used on automobiles. A simple arrangement, it should suggest many changes in engine design. Highest torque developed by the engine is lowered by 500 rpm, and a lower grade fuel may be used.

Gasoline Injection System Ready for Automobiles

American Bosch, long a manufacturer of fuel injection equipment for diesel engines, branched out to broader fields with the announcement that it had perfected a new practical gasoline injection system for automobile engines. The new injection system replaces the carburetor on an engine, and does not resemble a carburetor in any form. The gasoline is injected directly into the cylinder or at a point in the manifold just above each intake valve. Just a few advantages, according to American Bosch, are: smoother engine performance, improved cold weather starting, less engine wear, smoother idling, freedom from vapor lock, use of cheaper fuel, and an efficiency increase in miles per gal of 15 per cent.

How It Works. The system consists of a small fuel metering and injection pump, a mixture or fuel-air-ratio control, an electrically driven fuel supply pump, injection discharge lines and nozzles, and a fuel filter.

As shown in the schematic diagram, the motor driven fuel supply pump sends fuel through the filter to the injection pump, keeping a pressure of 17 psi, high enough to prevent vapor lock. The injection pump is of the single plunger type with the plunger reciprocated by an integral face cam which pumps the fuel to each cylinder injection nozzle. The positioning of a sleeve on the plunger controls the amount of fuel that is injected. The control pressure from the mixture control is translated through a shaft to the plungers metering sleeve.

This mixture control is a manifold pressure type with its throttles connected directly to the accelerator pedal. A chamber in the mixture control feeds a modified manifold pressure to the injection pump control during cold starting and idling. The

fuel sprayed through simple poppet type injection nozzles is carried into the cylinder during the intake stroke. Injection pressure is between 60-80 psi. Cooling problem on intake valve is reduced and temperature is 70 F less than that using a carburetor.

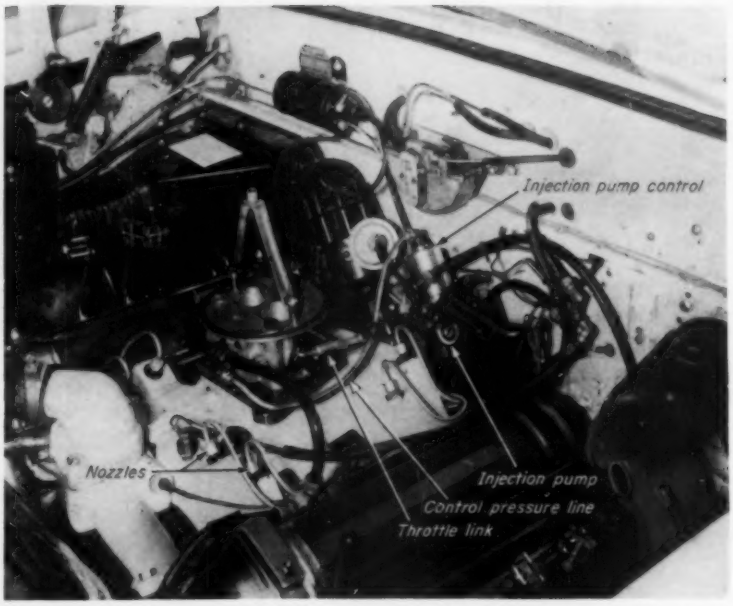
While the fuel consumption is less at all speeds with the injection system as compared to the conventional carburetor, it is most economical at decelerating or idling speeds and engine operation is much smoother at these speeds. There is a more accurate fuel distribution to each engine cylinder for the fuel pump takes in a full charge at all times and returns to the tank all that it does not want. Thus, no cylinder must run too rich to insure that none runs too lean.

Each unit must be set according to the engine and type of gas used, and does not require adjusting unless there is a radical departure in the type of fuel used (high to low octane). Fuel injection system is unique in that the same one is used for all cars, with adjustments made according to each engine as the system is installed. With the injection system, it will be possible to get the same horsepower out of the same engine using a fuel of octane of five points less.

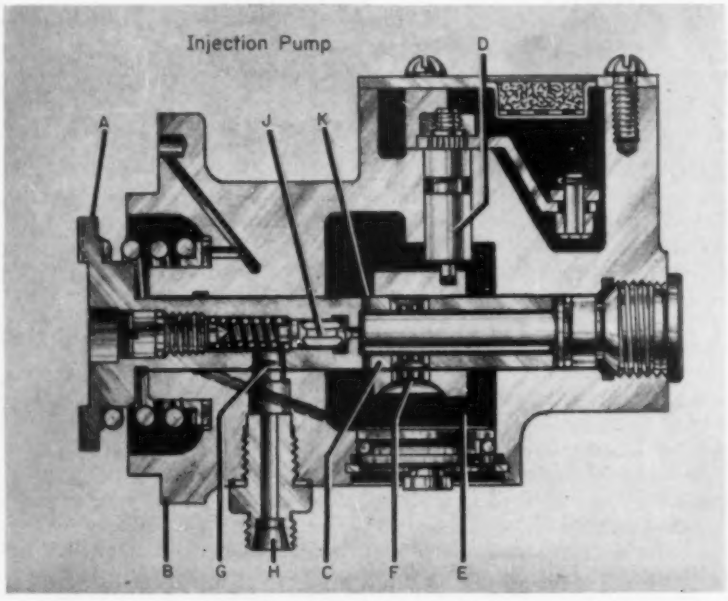
Peak torque developed by the engine is lowered about 500 rpm, and the torque flattens out. Acceleration is improved because of a more instant response to fast or slow throttle movements.

Lowering hood lines from 4 to 6 in. will be possible with the carburetor gone. The air cleaner, for example, can be located any place, perhaps up front.

American Bosch, a division of the American Bosch Arma Corp., Springfield, Mass., will only go so far as to say that "several prominent automobile manufacturers" have been testing the injection system and the chances are good that it will be used in some of the 1958 model cars. The cost will be high initially—perhaps double that of the conventional carburetion system, but with volume production and refinements, Bosch expects the cost to be about the same. Also, the company feels that it is not impossible for such a device to eventually fall in the "do-it-yourself" category. Installation time, it was reported, is approximately three to four hours.



ARRANGEMENT OF INJECTION SYSTEM COMPONENTS under the hood. Mixture control throttle body with cover off is in center. Mounted directly on the injection pump is the injection pump control. Through the tube leading from the top of this unit to the mixture control throttle body, the injection pump control receives control pressure which is transmitted to the metering shaft of the injection pump.



SECTIONAL VIEW OF INJECTION PUMP shows (A) face cam and plunger, which is reciprocated and rotated by the engine's drive mechanism at ½ engine speed. The metering sleeve (C) fitted to the plunger is adjusted for fuel metering by the eccentric pin at the end of control shaft (D), which is linked to the pump control. Fuel enters sump (E) and during suction stroke fills the internal volume of the plunger through the radial ports (F) in the plunger and sleeve. As the plunger turns, the fill ports are covered at the end of the suction stroke and distributing port (G) lines up with one of the outlets (H). Fuel is forced out through spill ports (K) to sump for the part of the stroke determined by the metering sleeve position.

Materials Notes . . . .

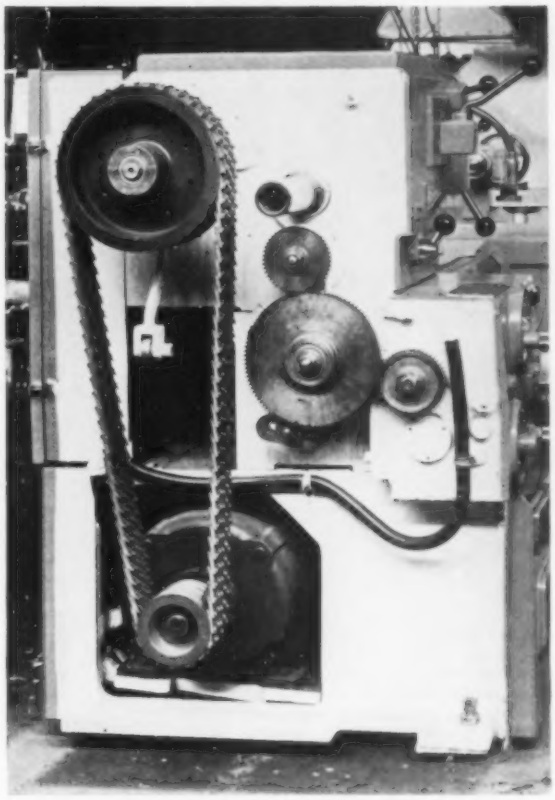
Aluminum . . . . Primary aluminum capacity in the United States will be increased by 220,000 tons with the construction of a new reduction plant by Kaiser Aluminum & Chemical Corp. Located in Ravenswood, West Virginia, the plant will increase Kaiser's basic capacity by more than 50 per cent, and is only one phase of a $280-million expansion program. No government aid, such as a certificate of necessity or fast tax write-off, is being used.

Plastics . . . . The Society of Plastics Engineers noted that the use of plastics for tooling purposes is on the increase. Sales in this field are expected to hit $10-million, in comparison to the 1951 sales total of $250,000.

Titanium . . . . Battelle Memorial Institute, Columbus, Ohio, is accumulating a sizeable amount of information on titanium in its roll as a "clearing house" for all information on this material. Given this job by the government Steering Committee on Titanium 6 months ago, Battelle will distribute this knowledge to companies working with titanium. This information results from government and privately sponsored research projects. However, under this contract Battelle is not authorized to conduct its own research when a question comes in and Battelle does not have the answer in its supply of data. Battelle can only recommend to the Steering Committee that such a project be undertaken.

Steel . . . . A new, high strength, free marking steel bar which requires no heat treating has been developed by the LaSalle Steel Co., Hammond, Indiana. It machines at least 25 per cent faster than annealed alloys and 50 to 100 per cent faster than heat treated alloys. Applications replacing both heat treated and hot or cold rolled steels are claimed by LaSalle.

Sandwich Material . . . . Narmco Mfg. Co., 1882 Moore St., San Diego 1, Calif., has saved an estimated 65 per cent in lay-up time on the manufacture of giant aircraft pods by using a new highly formable sandwich core material. Measuring up to 20 ft long and 5 ft in dia, the pods are fabricated from aluminum Multiwave aluminum foil core which is bonded to phenolic-impregnated fiberglass faces.



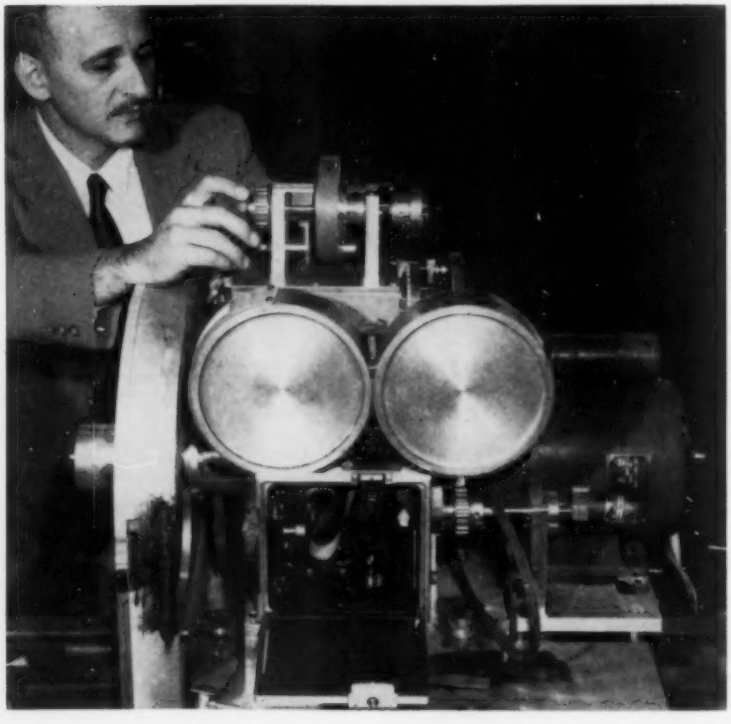
EDITOR'S ERROR: The photograph above was captioned incorrectly in the staff report "Selected Designs of Machine Elements," page 135 of the November 1955 issue of *Product Engineering*. The belt drive on this Springfield lathe was incorrectly described as "sectioned-leather." Actually, it is a Veelos adjustable v-belt, made of rubber and duck. Its outstanding features are (1) lower vibration because of its unique construction and balanced design; (2) ease of installation, and (3) it is adjustable to any length. Veelos is a product of Manheim Manufacturing and Belting Company, Manheim, Pennsylvania.

Fire Retardent Paint . . . . The Army Engineers Research and Development Lab. at Fort Belvoir, Va., announced a group of paints which will slow down the rate of burning. The paints do not stop fires, but aid considerably in minimizing the damage.

Machine Tools . . . . The U.S. Air Force will spend $52.9-million to buy new machine tools for stepping-up aircraft production. The plan is not connected with the Machine Tool Stockpiling Program which was eliminated (with $170-million to go) in the search for budget cuts. In the new program, the Air Force buys the machine tools and assigns them to the aircraft manufacturers.

THE NEWS IN PICTURES

THE XH-40, the Army's new single-rotor, turbine-powered helicopter designed by Bell Aircraft Corp., Fort Worth, Texas. Using a Lycoming XT-53 free-power turbine, this 6-place helicopter has a vertical climb rate of 1900 ft per min, and hovering ceiling of 15,000 ft. The XH-40 is the first helicopter to have in-flight blade tracking, a device to trim the blades for smoother flight. Weight and wear savings result from all-metal rotor blades and a new rotor hub design. Bell claims an empty weight reduction of 35 per cent, a 100 per cent increase in payload, and a 43 per cent increase in cruising speed compared to similar reciprocating engine driven helicopters now in use. The XH-40 can be tilted backward by pump-down skid wheels, permitting easy field repair. Mock-up does not have main rotor blades installed.



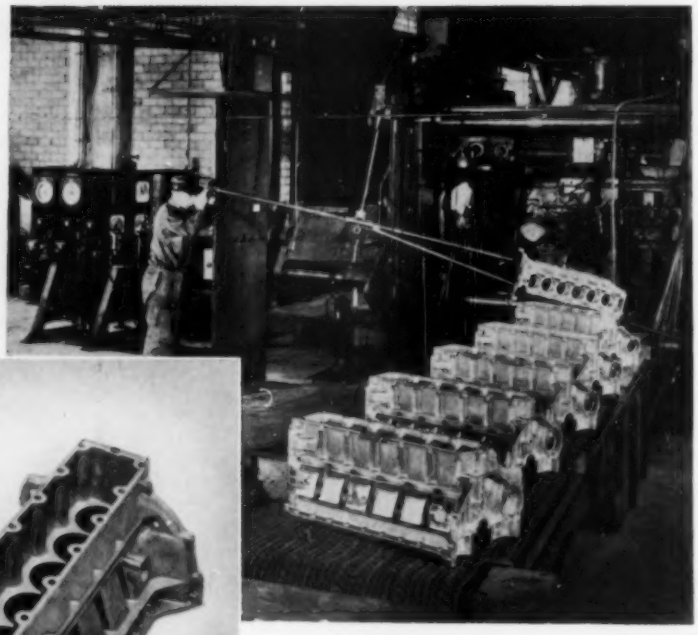
EXPERIMENTAL MODEL OF AN X-RAY motion picture apparatus developed at the University of Rochester Medical Center is shown coupled with an announcement by General Electric that it is going into production of the first commercial units in this country. The apparatus can be used in any position with conventional X-ray equipment, and has a picture taking area of 16 x 15 in. (conventional X-ray film is 14 x 17 in.). The device can be used with either 16 mm or 35 mm film and offers a speed range of 3¾ to 30 frames per second. Heart of the device is a f/0.71 lens, and an electronic triggering mechanism which turns the 100,000 to 130,000 volt X-rays on and off up to 30 times a sec in synchronization with the motion picture camera, minimizing the X-ray dosage that the patient receives.

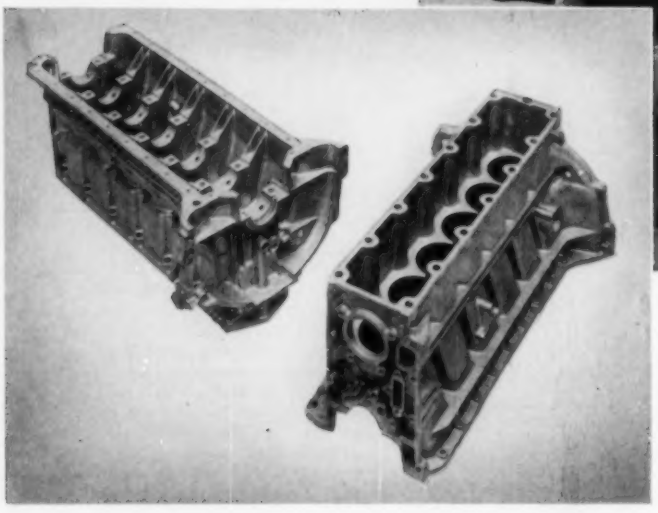
A DESK-TOP ANALOG COMPUTER, in addition to offering more flexibility to large computing sections, also will find use in the small company where the amount or extent of the problems do not warrant a full-sized model. The Miniputer was developed by Saunders-Roe Ltd., Southampton, England, to solve simple aircraft flutter and vibration problems and simultaneous equations; to analyze linear servomechanisms; and to train operators for larger machines. It can solve problems expressed in terms of linear differential equations whose total of variables, plus derivatives does not exceed ten. Printed tape facility can be built in if necessary. Power unit is under the desk. Approximate cost in this country is $3000.

AN AIRBORNE DIGITAL COMPUTER developed by the Missile and Control Equipment Operations, of North American Aviation, Inc., is being checked before installation in a plane. Incorporating about 1000 transistors, the computer will automatically and continuously process in-flight data. The entire unit occupies only three cubic feet, weighs 125 lb, and uses less than 100 watts. It contains 51 standardized printed circuit panels for quick service and replacement. It was designed for U. S. Air Force use and can continuously integrate 93 quantities simultaneously and solve differential and trigonometric problems.

TAKING A GAMMA RAY PHOTOGRAPH of a weld in a high pressure pipe using the small ASS52 gamma ray machine made by the M. Falk & Co. Ltd., 5 Victoria St., London, S.W. 1, England. Device holds five curries of iridium 192. Series of illustrations shows (left) film in light-tight envelope placed in a tension holder over the weld in the pipe; (right) operator on the opposite side of the pipe opens aperture of gamma ray machine allowing rays to escape and make shadow photograph on the film. The machine can be set at any angle from 0 to 90 degrees. A larger machine carries a load of 3-4 curries of cobalt 60.

Production Line Aluminum Die Cast Engine Blocks





Rolling off an experimental production line (above right) at the rate of 30 to 35 per hr from one machine are the first aluminum die cast 6-cylinder engine blocks. At left are the top and bottom sections of the engine. Manufacturer is the Doehler-Jarvis Div., of the National Lead Co., Toledo, Ohio, owners of the world's largest die casting machine—72 in., and capable of handling dies weighing up to 50 tons.

At the rate of 35 per hr, about 1700 lb of molten aluminum are used. The engine block weighs 50 lb when it comes from the machine, and 43 lb when trimmed. This is the largest die casting made in aluminum. All 129 holes are cored and cast to size; no holes have to be drilled. The same engine block in gray iron would weigh about 175 lb. Doehler-Jarvis estimates a 10 per cent price advantage over the conventional gray iron block.

Cost savings are gained because the only machining necessary on the die cast block is confined to the main sealing areas. In addition, because the heat conductivity of aluminum is higher than that of gray iron, an engine block of aluminum needs a less complicated cooling system. The smooth surface of the die castings prevents the occurrence of uncontrollable sand pockets, restricting cooling water flow.

On the basis of the work done on the 6-cylinder block, the development of a V-8 aluminum die cast engine block is under way which will weigh between 70 and 75 pounds.

Broad Defense Mobilization Base Out of Date?

In Washington, with the Subcommittee of the joint Congressional Committee on the Economic Report, witnesses argue not only the pros and cons of protecting U.S. industries from foreign competition on defense grounds, but also the validity of a broad defense mobilization base in an H-bomb era. A number of industries are requesting special protection from imports on the grounds that they are essential to the national defense (Watch Tariff, *Product Engineering*, August 1955, p 123). Those wanting a more liberal foreign policy, such as the committee for a National Trade Policy, will campaign against the restricting of imports for defense reasons.

This committee, headed by Rep. Bolling, heard Richard S. Leghorn, former Air Force Colonel, and consultant to Harold Stassen on Disarmament problems, say that the whole concept of building a broad defense mobilization base has been rendered obsolete by the development of nuclear weapons.

Leghorn disagrees with the whole idea of building stockpiles of strategic materials, standby armament production capacity, and pools of special skills. "The reason that such a defense setup would be useless in World War III," Leghorn says, "is that a

substantial portion of U.S. industry would be destroyed at the outset. The decisive phase of the war would be over in weeks, not years, long before reserve military production capacity could be made to count."

Leghorn feels that the huge cost of maintaining this standby production capacity would reduce the funds available for creating such deterrent forces as the strategic air forces and the tactical atomic units.

The opposite view is presented by Samuel Lenher, of the Synthetic Organic Chemical Manufacturing Association. He backs the defense mobilization concept, and the protection of industries essential to national defense. These industries would be: those whose capacities have been expanded to meet defense or essential civilian needs; industries easily convertible from peacetime to wartime production; those in which skilled manpower is necessary; those carrying on extensive research; and those industries using domestic raw materials or whose products would be adaptable as substitutes in time of war.

Continuous-Cast Bearing Bronze Up to 9 in. Diameter

Sizes of continuous-cast bearing bronze have been increased from a previous maximum of 5 in. dia up to 9 in. in diameter, and in a variety of shapes and alloys up to 12 ft in length. This advance has just been announced by the Continuous-Cast Products Dept., of the American Smelting & Refining Co. (Asarco), Barber, New Jersey.

The basic continuous casting process is the same, with molten metal supplied by an auxiliary melting furnace being poured into water-cooled graphite dies, solidifying and being pulled down vertically in 4-story high production lines. Diameters range from ⅛ to 9 in., with travelling saws attaching themselves automatically to the continuous cast part to cut the metal to the specified lengths.

The process is a gravity-feed, bottom-flow casting process; therefore, impurities such as dirt and dross have been eliminated, with fatigue properties increased to 33 to 100 per cent. Impact strength has been improved 15 to 100 per cent.

COMING EVENTS

JAN. 18-20

Society of Plastics Engineers, 12th Annual Conference, Hotel Statler, Cleveland, Ohio. Subjects to be covered in the meetings: Injection molding technique and machinery; extrusion technique; calendering and casting; reinforcement by fibers, cloth, elastomers; irradiation; foams; physical properties; research; tooling and molds; automotive and aircraft applications; and defense applications. For information contact: S. A. McElroy, Hercules Powder Co., 865 Union Commerce Bldg., Cleveland, Ohio

JAN. 30-FEB 3

1956 Winter General Meeting of the American Institute of Electrical Engineers, Statler Hotel, New York, N. Y. There will be 380 papers presented in 95 sessions and symposiums. Subjects of the sessions are, electrical developments in the: chemical industry; mining and metals; petroleum; communications; land transportation; and the textile industry.

FEB. 7-9

11th Annual SPI Reinforced Plastics Div. Conference, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J. Subject of symposium to be Fatigue and Creep-Rupture of Reinforced Plastics. The symposium will bring together speakers with the latest information, pointing up areas needing further investigation. Authors who wish to submit papers should submit abstracts to: C. R. Stock, American Cyanamid Co., Stamford, Conn.

MARCH 12-16

12th Annual Corrosion Conference of the National Society of Corrosion Engineers, Hotel Statler, New York, N. Y. There will be a variety of discussions on: corrosion principles; chemical inhibitors; steel metallurgy; power and communications; high temperature corrosion; plastics; protective coatings; and instrumentation.

MARCH 14-16

Conference, Aviation Div., American Society of Mechanical Engineers, Hotel Statler, Los Angeles, Calif.

MARCH 19-23

24th Annual Convention and Exposition of the American Society of Tool Engineers, International Amphitheatre, Chicago, Ill. Theme will be "Tooling for Tomorrow." Over 60 papers will be presented, and 12 plant tours have been arranged.

MARCH 26-27

Instruments and Regulators Div., of the ASME, Conference, Princeton University, Princeton, N. J.

APRIL 10-12

12th Annual Meeting of the Metal Powder Association, and the 1956 Metal Powder Show, Hotel Cleveland, Cleveland, Ohio. The meeting will cover structural parts, bearings, filters, friction materials, cores and others.

APRIL 11-13

The 7th Region Technical Conference, of the Institute of Radio Engineers, Hotel Utah, Salt Lake City, Utah. Program of technical papers and field trips is planned. Papers should be forwarded to: Mr. Larry S. Cole, Utah State Agricultural College, School of Engineering & Technology, Logan, Utah.

APRIL 18-20

National Industrial Research Conference, sponsored by the Armour Research Foundation as part of their 20th Anniversary, Illinois Institute of Technology, 35 West 33rd St., Chicago 16, Ill. Twelve papers will be presented, with a number of industrialists and research directors taking part in a program designed to guide industry in the administration of more profitable research.

MAY 14-17

First Design Engineering Show, Convention Hall, Philadelphia, Pa. The first show of its kind, it will be devoted to, and will have on exhibit, all types of original equipment which go into the manufacture of a finished product. The show is an outgrowth of another show called The Basic Materials Show.

The National Merit Scholarship Corporation

Business is Offered Big Dividends on Investment in Higher Education

The McGraw-Hill Publishing Company is availing itself of the opportunity to establish ten National Merit Scholarships. They will be known as the McGraw-Hill Merit Scholarships. The scholarships are to be awarded to qualified candidates for a four-year college course in the fields of science, engineering and the other professions and the liberal arts. There will be no limitation, beyond the appropriate professional accrediting, on the college or university selected by a successful candidate. As part of a continuing program to aid higher education and educational institutions, McGraw-Hill is happy to be able to share in what it believes to be the constructive educational endeavor of the National Merit Scholarship Corporation.

Business firms searching for a satisfactory avenue to provide financial aid for our colleges and universities now have a new opportunity of major importance. It is provided by the National Merit Scholarship Corporation, which has offered to devote $8 million to matching, dollar for dollar, gifts by business firms for college scholarships and supplemental gifts to the institutions where the scholarships are used.

The National Merit Scholarship Corporation, an independent agency financed initially by gifts of $20 million from the Ford Foundation and $500,000 from the Carnegie Corporation, has three major purposes which are closely related. They are:

1. To locate those of the nation's young men and young women who are best equipped to go to college.

2. When necessary, to help these young people go to college by giving them financial aid.

3. To help colleges and universities meet the full cost of the instruction of those to whom National Merit scholarships are granted.

At present about half of the nation's top high school graduates do not go to college. The principal reason is that they do not have the money required.

To Save Unused Brain Power

The National Merit Scholarship Corporation will strive to eliminate this dangerous neglect of top-flight ability. To this end it is inviting the nation's high schools, numbering more than 24,000, to participate in its program by designating as available candidates for National Merit scholarships the top 5 percent of their senior classes. Those so designated are then invited to take a series of tests and to submit reports designed to assure selection of the very best talent in each state. The number of scholarships to be allotted to each state will be proportionate to the number of high school graduates in the state.

The winners, the total number of whom will be determined by the amount of money the Scholarship Corporation has available, will be eligible for awards. For those who need no financial help to go to college there will be honorary awards of $100. For those who must have help the Corporation will grant scholarships covering as much as necessary

of the cost of instruction and living expenses for a four-year college course.

Colleges Get Financial Help

The provision of funds to cover the students' expenses does not, however, solve the financial problems faced by many colleges. That is because the tuition charges paid by the students do not cover the cost of the instruction. The deficit must be met by drawing upon endowment funds, gifts, grants, and other available sources.

Consequently, to prevent holders of National Merit scholarships from imposing any additional financial burden on the colleges and universities they elect to attend, the Corporation will make a supplementary grant to these institutions. The supplementary grant will be the equivalent of regular tuition charges made by the school, with a top limit of $1,500 a year for both the tuition and the supplement.

As the scholarship grants to the winning students will vary, depending upon how much financial help they need, so will the supplementary grants vary from one college to another, depending on their regular tuition charges. However, it is anticipated that on the average the full cost of a National Merit scholarship—including aid to the student and the supplement to the college—will be about $1,500 a year.

Many business firms will find a compelling appeal in a program which is designed at once to mobilize the nation's intellectual resources more effectively and, in the process, give very badly needed financial help to our colleges and universities.

Two For One Return Offered

However, there are numerous other inducements to business firms to finance National Merit scholarships. These scholarships may:

1. Carry the name of the firm or be named in honor of someone designated by the firm.
2. Be limited to use in types of colleges of particular interest to the sponsoring firm.
3. Be limited to a college course, such as science, engineering or liberal arts, of special concern to the sponsor.
4. Be restricted to candidates or institutions in geographic areas specified by the sponsor.

In addition to these advantages there is a special financial inducement to help the Merit Scholarship program. It is that for every Merit scholarship a firm or individual finances, the Corporation will, up to the limit of $8 million, match the funds and make another National Merit scholarship available.

There are many good ways of helping our financially beleaguered colleges and universities, and many corporations are already using one or more of them.* For those companies that can do so without embarrassing complications one of the best ways is to make unrestricted gifts directly to the institutions. But this new way provided by the creation of the National Merit Scholarship Corporation (Address: 1580 Sherman Avenue, Evanston, Illinois) has the broad appeal of serving two purposes of transcendent importance simultaneously. The purposes are to see that our best brains are fully trained and utilized and that our colleges and universities, crucial contributors to this process, are helped at the same time. Business will serve the nation and its own community well by giving the National Merit Scholarship Corporation generous help.

---

* These, as well as the plight of our colleges and universities, are discussed in a pamphlet, "Business Aid to Our Colleges and Universities," which embodies a series of five editorials which appeared in all McGraw-Hill publications. Copies of the pamphlet can be obtained without charge by addressing the Department of Economics, McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York 36, New York.

Methods of helping our colleges and universities financially are also outlined and discussed in a pamphlet, "Aids to Corporate Support of Higher Education," which may be obtained without cost by addressing the Council for Financial Aid to Education, 6 East 45th Street, New York 17, New York.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw

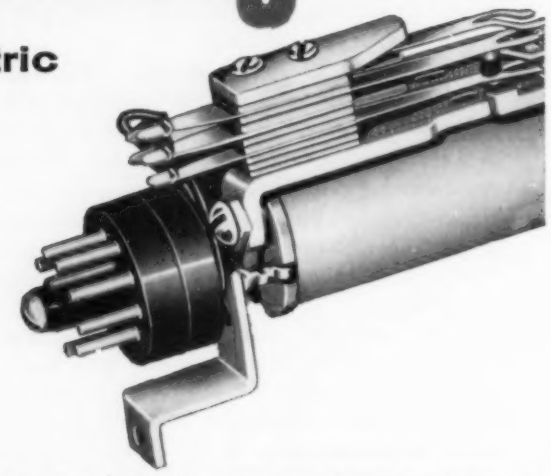
PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

you can have the advantages of

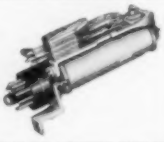
plug mounting

in all these Automatic Electric relays

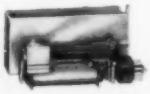


CLASS A:
The "all-purpose" relay for use where first cost is important. Gives long, dependable service. Size: 4⅜" x 2³⁄₁₆" x 1⁷⁄₁₆".

CLASS B:
Made for extremes of long service life and dependability — often exceeding 400 million operations! Size: 4⅜" x 2³⁄₁₆" x 1¼".



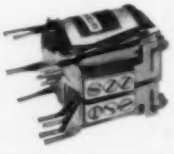
CLASS F:
Low operating power makes this relay especially desirable in a.c. circuits where relays function without specified operate or release time delays. Size: 4⅝" x 1¹⁵⁄₁₆" x 1¼".



CLASS S:
Made for exacting miniature requirements. Used in aircraft where resistance to shock and vibration is needed in a small, light, reliable relay. (For printed circuit applications—see below.) Size: 2⁹⁄₁₆" x 2" x 1¼".

CLASS Z:
Provides maximum timing in a "small-as-possible," low-cost relay. Compact, light, resistant to shock and vibration. Size: 3¼" x 2⅞" x 1¹³⁄₃₂".

"PLUG-IN" RELAY FOR PRINTED CIRCUITS.
Design of coil and spring terminals permits direct insertion into printed circuits with high-conductance connections, easily soldered. Bearing design gives up to 120 million operations without readjustment or relubrication. Size: 1¾" x 1⁵⁄₁₆"-1¾" (depending upon number of contact springs) x 1".



For any application, you can choose an Automatic Electric relay—a top-quality relay in every way—with the additional advantages of *plug mounting:*

Minimized inventory—When you standardize on plug-in relays, you can often interchange the same basic relay in many models of your equipment. Thus, you make substantial savings by reducing your inventory costs, speeding assembly.

Fast, simplified inspection and maintenance—Plug-in relays permit periodic bench inspections with almost no "down time" involved. Entire banks of relays can be removed for testing, and then replaced, in *seconds.*

Simplified replacement—Plug-mounted relays can be replaced quickly and easily at otherwise inaccessible points in your equipment. Even an unskilled service man can replace relays in a matter of seconds without tampering with circuit wiring.

You can select Automatic Electric plug-in relays from five basic types and thousands of individual assemblies.

Send for Relay Circulars 1800—1804—They give complete specifications, dimensional drawings, and helpful information. *Address* Automatic Electric Sales Corporation, 1033 West Van Buren Street, (HAymarket 1-4300) Chicago 7, Illinois. *In Canada:* Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

RELAYS SWITCHES
AUTOMATIC ELECTRIC
ORIGINATORS OF THE AUTOMATIC DIAL TELEPHONE
CHICAGO

Calculating Mass Moments of Inertia

M. KLOOMOK
Manager, Scientific Computation Lab., International Business Machines Corp.

R. V. MUFFLEY
Associate Engineer, International Business Machines Corp.

TWO NOMOGRAMS PROVIDE A MEANS for quickly calculating mass moments of inertia of cross sections of any shape and for any material.

The bar nomogram is restricted to cylinders. Convert for materials other than steel by multiplying chart value by material factor C_m, which is the ratio of density of given material to density of steel. Scale factors C_L and C_D are used to compensate for lengths and diameters outside range of scales.

EXAMPLE:

Find J for an aluminum disk $L = 0.2$ in. thick and $D = 14.5$ in. dia.

For on-scale values adjust decimal points: $L' = 2.0$, $D' = 1.45$. From chart obtain $J' = 0.00062$. Multiply by scale factors:

$$J = J' (C_L) (C_D) (C_m)$$
$$= (0.00062) (0.1) (10{,}000) (0.34)$$
$$= 0.21 \text{ in.-lb-sec}^2$$

Mass moment of prismatic bodies of any cross-sectional shape can be obtained by using the circular nomogram as follows:

1. Trace cross section on Fig. 2 so that the axis of rotation falls on center. If necessary, drawing of part can be enlarged or reduced to suit.

2. Count the number of boxes per ring covered by the tracing and enter values in column 4 of table on the left of nomogram. If a full ring is covered by the part, the value in column 4 will correspond to value in column 2.

Divide the box count per ring by total number of boxes per ring and multiply by the total J per ring, to give net J per ring for part:

$$\text{Column 5, net } J \text{ per ring} = \frac{(\text{column 4}) \times (\text{column 3})}{\text{column 2}}$$

4. Add up column 5 to obtain the total J'.

5. Correct for thickness, scale and material factors as follows:

$$J_{\text{actual part}} = (J') (L) (C_s) (C_m)$$

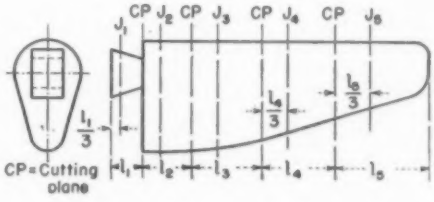
where

L = thickness of part, in.

C_s = scale factor = (scale of part drawing)$^{-4}$. For example, if drawing had been reduced to half-scale before tracing (Step 1), C_s would be $(1/2)^{-4}$, or 16.

C_m = material factor, as given on bar nomogram.

For mass moment of inertia of an irregular object, an approximation can be made by slicing the object into laminae using a series of cutting planes perpendicular to the axis. Individual J values for each lamina are added to give the total J. Cutting planes should be taken at each point of discontinuity, such as the first CP in the figure below.



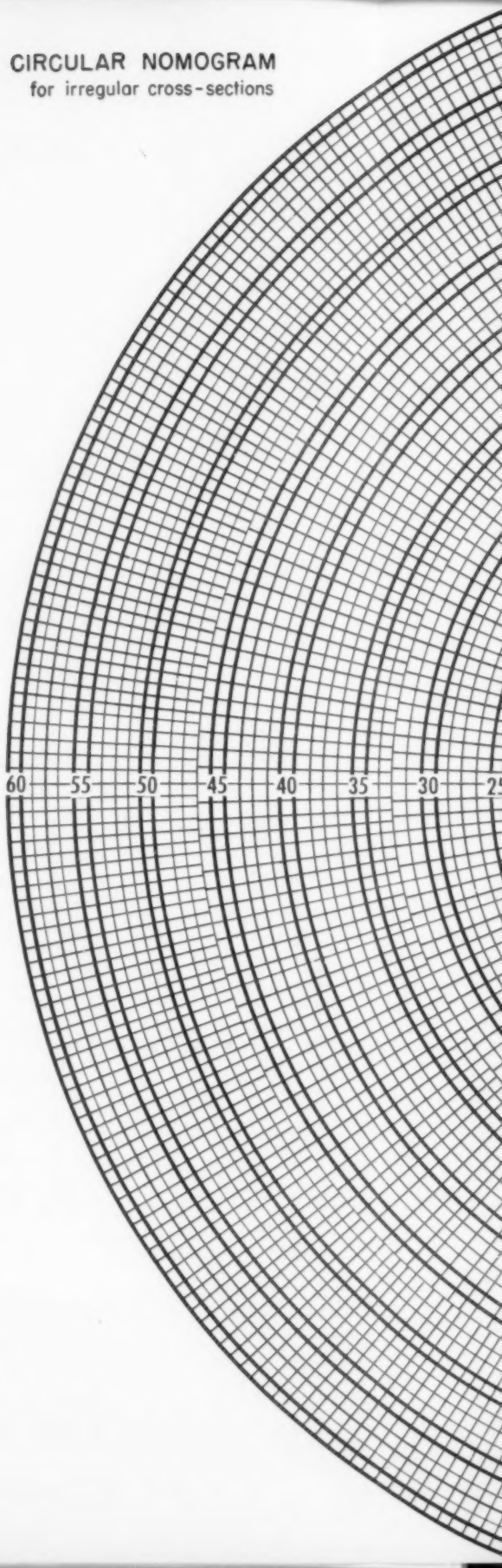
Cutting planes should also be taken so as to produce essentially prismatic or conical sections. For conical laminae, the mass moment of each should be calculated at a point (such as J_1) approximately one-third from the large end.

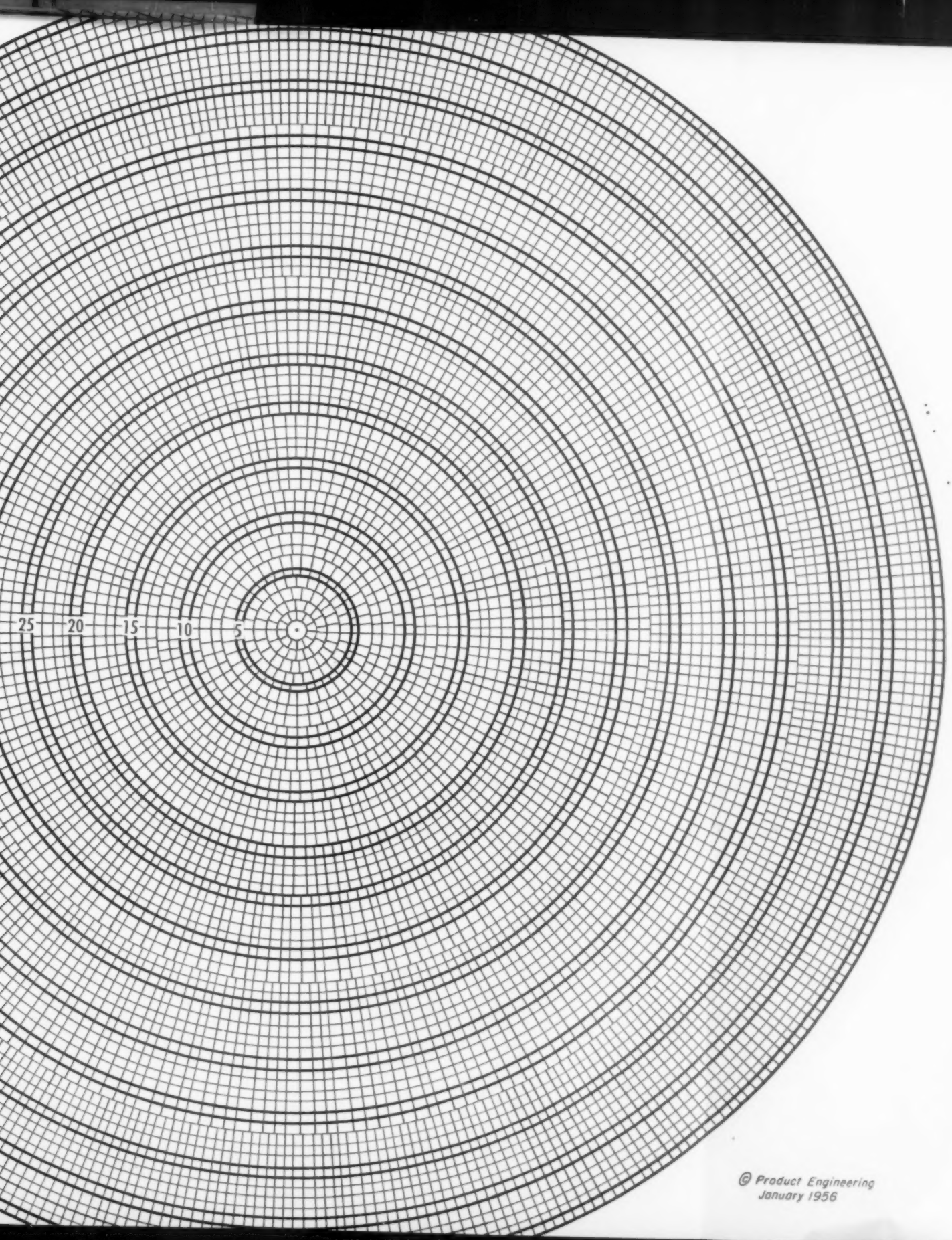
If the actual object is available for test, an experimental determination of J can be quickly made by supporting the object on pivots and measuring the time of oscillation. This procedure is described in "Determining Rotor Inertias by the Pendulum Method," D. K Wright, Jr., *Product Engineering*, May 1952, p 233.

RING	BASIC DATA (1) J BOX X 10^{-6}	(2) TOTAL BOXES PER RING	(3) TOTAL J RING X 10^{-3}	CALCULATIONS (4) BOX COUNT PER RING	(5) NET J RING X 10^{-3}
1	0.144	12	0.0017		
2	0.416	18	0.0075		
3	0.840	24	0.0202		
4	1.45	30	0.0435		
5	1.93	40	0.0772		
6	3.18	40	0.127		
7	4.07	48	0.195		
8	5.91	48	0.284		
9	6.60	60	0.396		
10	8.91	60	0.535		
11	8.77	80	0.702		
12	11.3	80	0.904		
13	12.6	90	1.13		
14	15.6	90	1.40		
15	19.1	90	1.72		
16	17.3	120	2.08		
17	20.6	120	2.47		
18	24.3	120	2.92		
19	28.5	120	3.42		
20	27.6	144	3.97		
21	31.8	144	4.58		
22	36.5	144	5.26		
23	41.5	144	5.98		
24	47.1	144	6.78		
25	42.5	180	7.65		
26	47.6	180	8.57		
27	53.2	180	9.58		
28	59.3	180	10.7		
29	65.7	180	11.8		
30	72.6	180	13.1		
31	80.0	180	14.4		
32	87.9	180	15.8		
33	72.2	240	17.3		
34	78.8	240	18.9		
35	85.9	240	20.6		
36	93.4	240	22.4		
37	101.	240	24.2		
38	110.	240	26.4		
39	118.	240	28.3		
40	128.	240	30.7		
41	137.	240	32.9		
42	147.	240	35.3		
43	158.	240	37.9		
44	169.	240	40.6		
45	181.	240	43.4		
46	193.	240	46.3		
47	137.	360	49.3		
48	146.	360	52.6		
49	155.	360	55.8		
50	165.	360	59.4		
51	175.	360	63.0		
52	185.	360	66.6		
53	196.	360	70.6		
54	207.	360	74.5		
55	219.	360	78.8		
56	231.	360	83.2		
57	243.	360	87.5		
58	256.	360	92.2		
59	270.	360	97.2		
60	283.	360	101.9		

CIRCULAR NOMOGRAM

for irregular cross-sections

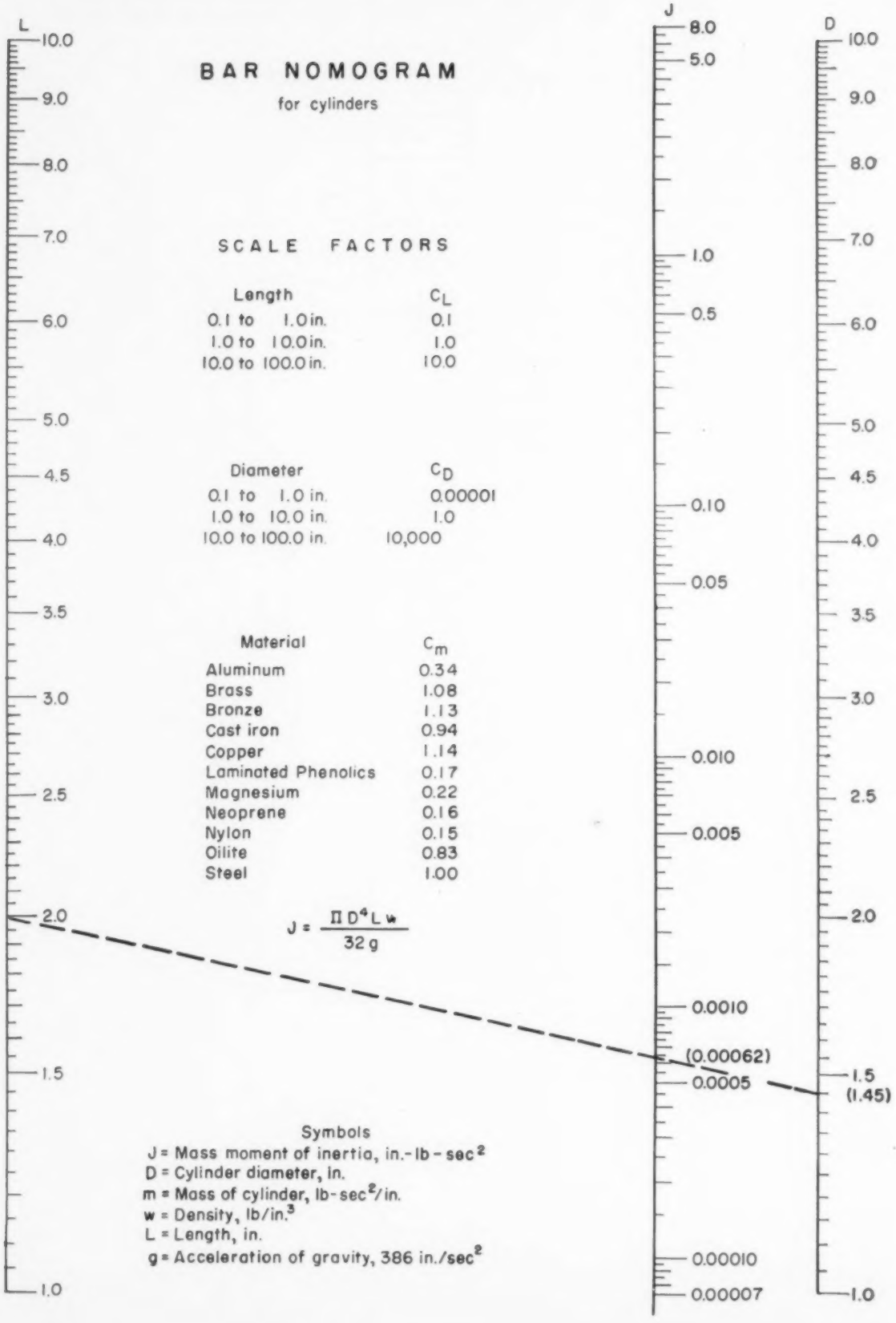




© Product Engineering
January 1956

BAR NOMOGRAM

for cylinders



SCALE FACTORS

Length	C_L
0.1 to 1.0 in.	0.1
1.0 to 10.0 in.	1.0
10.0 to 100.0 in.	10.0

Diameter	C_D
0.1 to 1.0 in.	0.00001
1.0 to 10.0 in.	1.0
10.0 to 100.0 in.	10,000

Material	C_m
Aluminum	0.34
Brass	1.08
Bronze	1.13
Cast iron	0.94
Copper	1.14
Laminated Phenolics	0.17
Magnesium	0.22
Neoprene	0.16
Nylon	0.15
Oilite	0.83
Steel	1.00

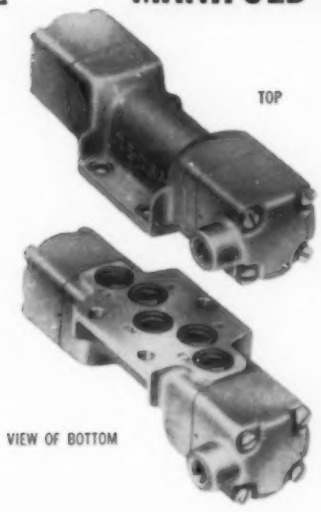
$$J = \frac{\pi D^4 L w}{32 g}$$

Symbols

J = Mass moment of inertia, in.-lb-sec^2
D = Cylinder diameter, in.
m = Mass of cylinder, lb-sec^2/in.
w = Density, lb/in.^{3}
L = Length, in.
g = Acceleration of gravity, 386 in./sec^2

for **maximum** capacity in **minimum** space...

VERSA MANIFOLD MOUNT VALVES



FOUR-WAY VALVE
TWO POSITION
PILOT ACTUATED
SPRING RETURN

The Versa Manifold Mount Valve is ideally suited for those installations where space is at a premium.

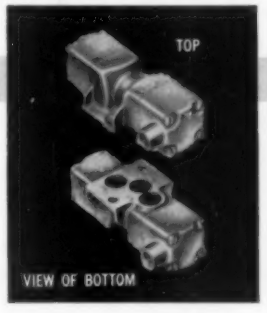
All piping can be installed, connected to Manifold Plate, and even purged before installation of the valve itself. The Versa Valve is simply installed by bolting into place on the Manifold Plate.

The valve proper, being independent of piping, can be easily removed for service or replacement without the extensive work normally involved in disconnecting piping or disassembling the valve.

Versa Manifold Valves are available with any type of actuating device in sizes from ⅛" to 1" NPT, in 2-, 3-, 4- and 5-Way for pressures from partial vacuum to 500 PSIG.

Versa has over 110,000 models and sizes available for immediate delivery. Standard Manifold Plates (or "Sub Plates") are available in rolled aluminum, but brass or steel plates can be supplied upon request.

All Versa Valves are triple pressure and functionally tested under water for guaranteed leakproofness.



THREE-WAY VALVE

TWO POSITION
PILOT ACTUATED
SPRING RETURN

The entire line of VERSA Valves is fully explained in our new comprehensive Folder No. 14. For your free copy, fill out Coupon below.

VERSA

VERSA PRODUCTS COMPANY INC.
249 SCHOLES STREET
BROOKLYN, NEW YORK 6, N. Y.

Versa Products Company, Inc.
249 Scholes Street
Brooklyn, New York

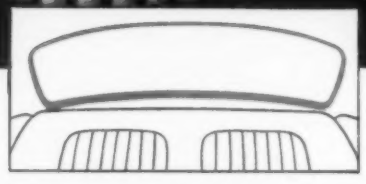
Please send me Folder No. 14

Name _____ Position _____

Firm _____

Address _____

City _____ Zone____ State _____



Dodge selects Enjay Butyl rubber for big rear-window weatherstrip

Super-durable Enjay Butyl fits perfectly Dodge's rigid specifications for its rear-window weatherstrip. Under the toughest conditions of weather and use, Enjay Butyl parts stay like new, help add style and color to new cars. In fact, some automobiles have more than 100 parts made of this fabulous rubber.

The many advantages of Enjay Butyl make it the almost perfect rubber for the automotive industry. Its price and ready availability are advantages, too. And it is now available in non-staining grades for *white* and *light-colored* parts. For full information and for skilled technical assistance in the uses of Enjay Butyl, contact the Enjay Company at either of the addresses below.

ENJAY

ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.
District Office: 11 South Portage Path, Akron 3, Ohio.

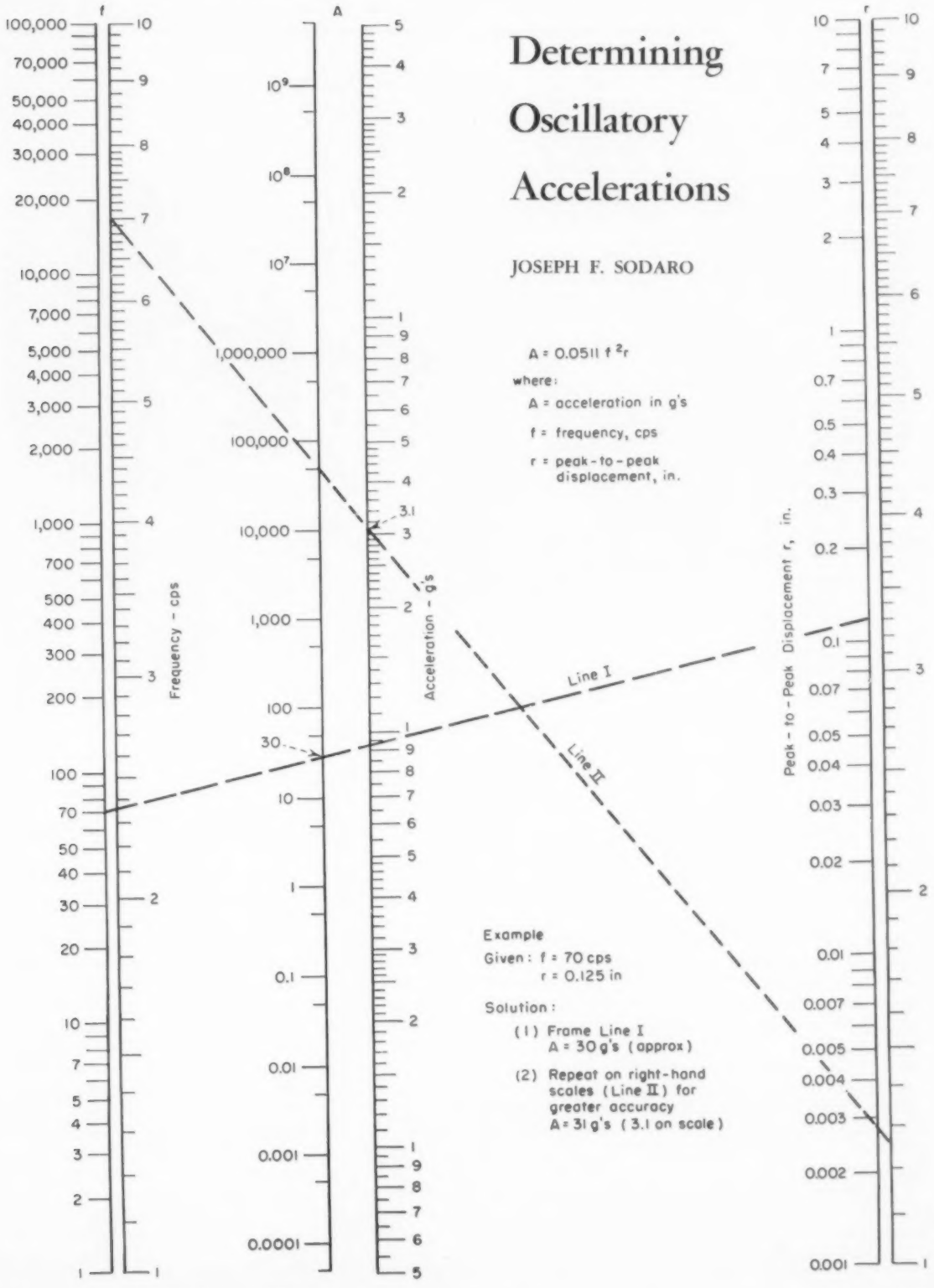
ENJAY
BUTYL

Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

36 SUCCESSFUL YEARS OF LEADERSHIP IN SERVING INDUSTRY

Determining Oscillatory Accelerations

JOSEPH F. SODARO



$A = 0.0511\, f^2 r$

where:

A = acceleration in g's

f = frequency, cps

r = peak-to-peak displacement, in.

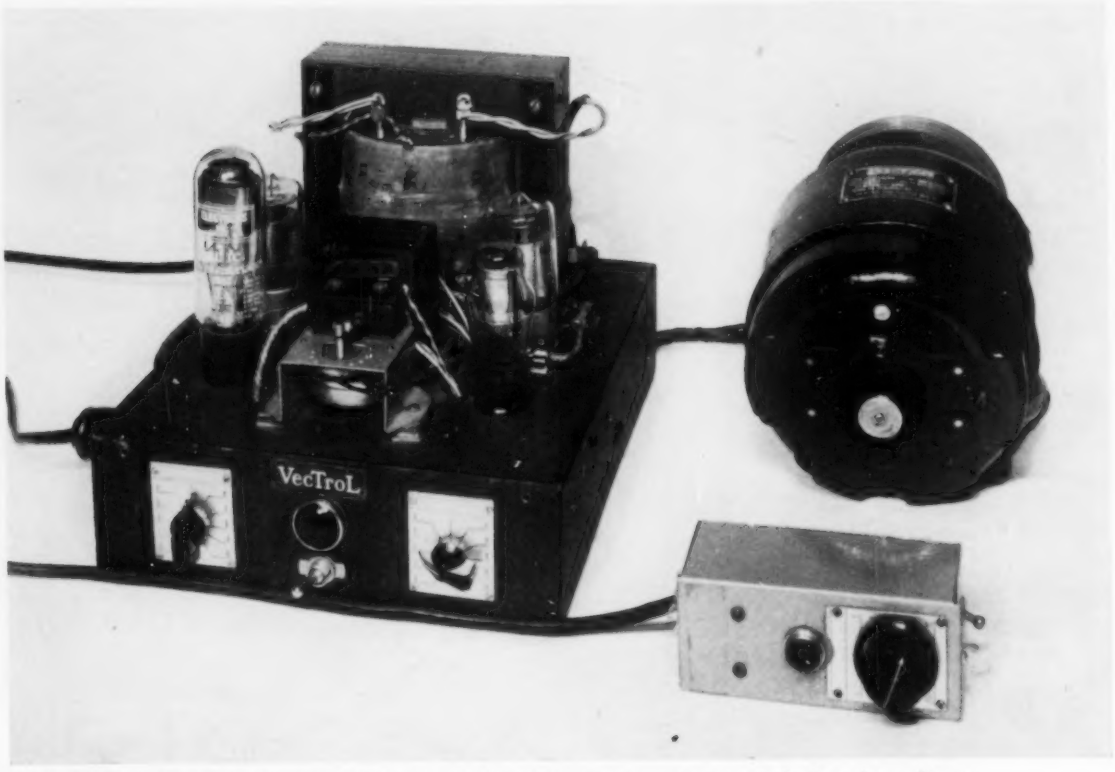
Example

Given: f = 70 cps
r = 0.125 in

Solution:

(1) Frame Line I
A = 30 g's (approx)

(2) Repeat on right-hand scales (Line II) for greater accuracy
A = 31 g's (3.1 on scale)



ADJUSTABLE FHP DRIVE is comprised of motor, half or full-wave electronic control circuit and an adjustor.

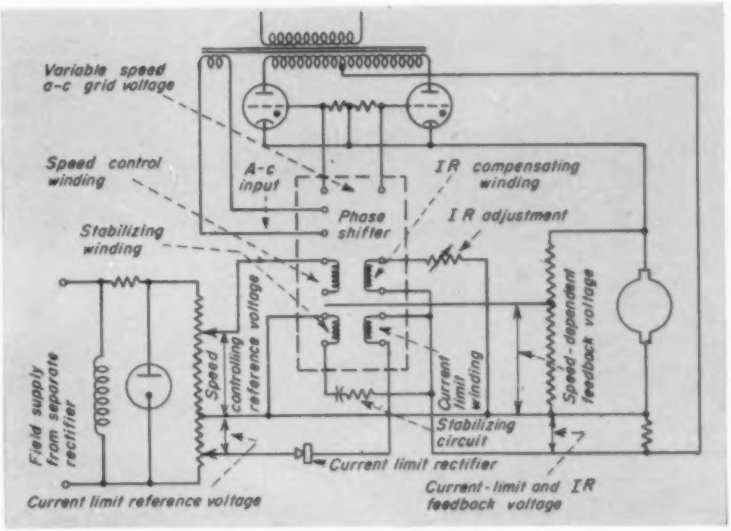
Adjustable Electronic Drive for Fhp Shunt Motors

This fhp electric motor drive for single-phase, a-c input provides continuously adjustable speed, which is practically independent of the load applied to the motor and of line voltage changes. It consists of a standard fhp, d-c shunt-wound (separately excited) motor, an electronic unit, and a speed adjustor. The adjustor is based on a small potentiometer, which may be mounted on the electronic unit or installed in a separate control station. By means of a circuit modification, constant speed with adjustable torque is also possible.

Overload protection can be provided by a current-limiting circuit which sharply limits the current and allows the motor to slow down instead of burning out tubes and motor or damaging the driven equipment if an excessive mechanical load is applied. The same current-limiting circuit provides rapid starting: the motor may be switched instantly to any desired speed from a standing start, accelerating as rapidly as possible.

The new electronic control may be designed to operate with almost any shunt-wound d-c motor having a frame size smaller than NEMA 203. The motor is usually wound for 230 v, and the field and armature windings are brought out to four separate terminals. Special units can be designed for 115-v motors. A 140-v d-c motor may be used with a single half-wave thyratron, direct from a 230-v, a-c line.

The full-wave circuit model is comprised of a transformer, a field rectifier (tube or dry type) a full-wave pair of thyratrons for supplying the armature, and the necessary control circuits. The transformer primary is wound for connection to any standard single-phase a-c supply voltage. The field rectifier is of the full-wave, gas-filled tube type, or alternately of the dry-disc selenium, copper oxide, germanium or silicon type. The armature supply is made up of a pair of thyratrons of suitable size, dependent upon the horsepower rating of the



FULL-WAVE SHUNT MOTOR drive circuit diagram has packaged thyratron grid control.

motor. This full-wave model makes it possible to use a smaller frame motor. Also, torque output is smoother.

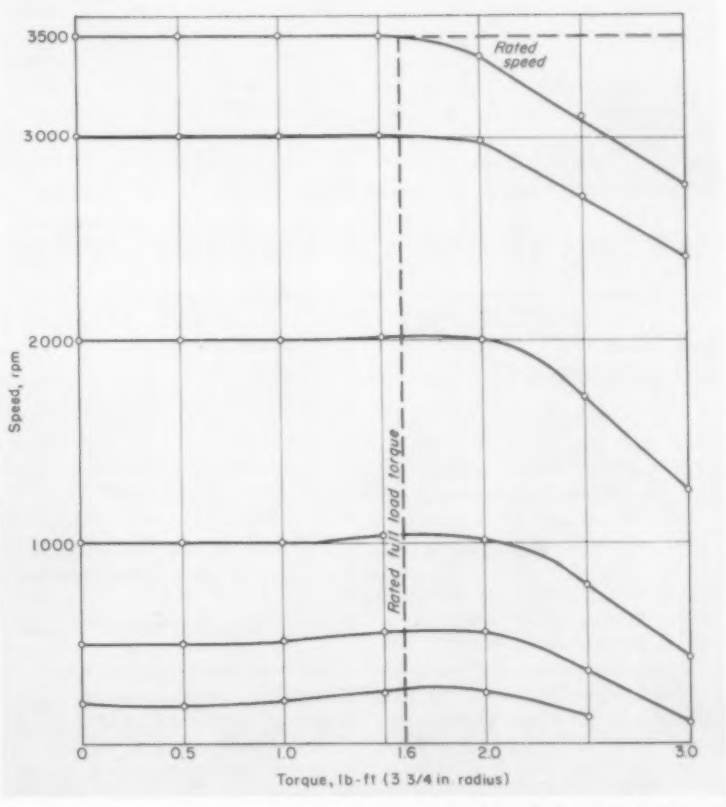
For low-cost applications, a single thyratron, half-wave unit is used without an anode transformer; the thyratron is connected direct to the 230-v, a-c line and drives a 140-v, d-c motor. Small drives can be developed for a 115-v, a-c line with a 60-v, d-c motor. In both models, the circuit is fail-safe since it uses no vacuum tubes and the motor shuts down as soon as the control signal is removed for any reason whatsoever, including field supply failure.

Motor speed is at all times adjustable over a range of 35:1 or more, by manually setting an adjustment device. The potentiometer used is supplied with a constant d-c reference voltage held by a voltage regulator tube so that the speed is substantially independent of line voltage fluctuations. Speed may be adjusted by an output signal from various types of outside sources.

Dynamic braking can be provided by means of a contactor which connects a braking resistor across the armature.

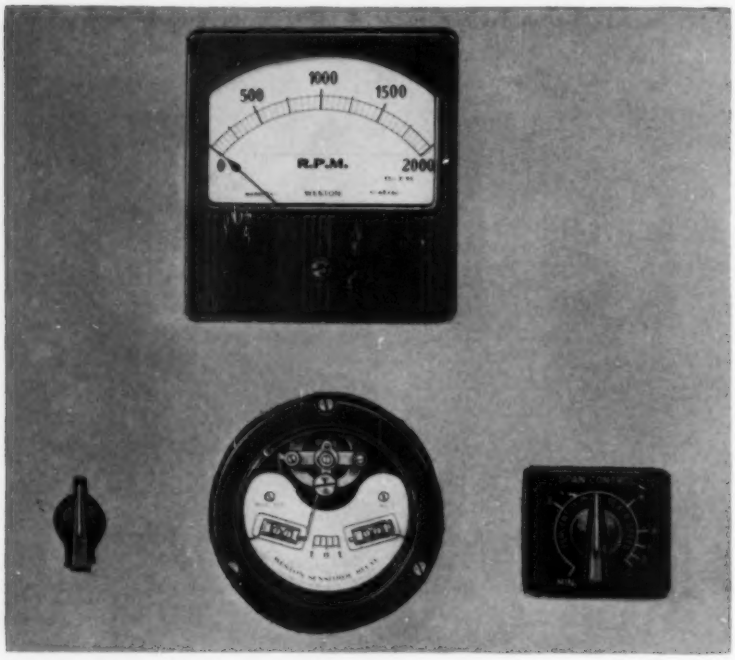
Complete automation of machine tool operation has been accomplished with the electronic unit shown in the right hand half of the accompanying photograph. This provides 16 preselected feeds over a 40:1 speed range, with almost instantaneous and precise speed change, and with provision for stopping the motor within one tenth of a revolution of a predetermined number of revolutions, from any speed up to as much as 6000 rpm. Vectrol Engineering, Inc., P. O. Box 1089, Stamford, Conn.

For more information—
Circle 1, inside back cover



TORQUE VS. SPEED curves for 1/3 hp, full-wave drive.

CONTINUED ON PAGE 224



Speed-change Sensing System

Designed especially for use in precision automatic speed control equipment, this new unit is said to react to a speed change as small as ¼ of 1 per cent of its top operating speed. It can be used at any speed up to 80,000 rpm. No vacuum tubes are used. While completely automatic in operation, the unit also incorporates a tachometer indicator to provide the operator with continuous speed indication. High accuracy, maintenance-free operation are claimed. Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

For more information—
Circle 2, inside back cover

Steel Nuts For Up To 800 F

A line of lightweight stainless steel anchor and gang channel locknuts for use to 800 F, and for applications where non-magnetic requirements exist, includes one and two-lug anchor or plate nut shapes. One floating nut body in the series has a 0.030 in. min radial float and another design offers multiple floating nuts installed in a strip of stainless steel channel. All of these designs are intended for blind mounted applications where the nut is "fixed" to the basic structure to simplify repair and replacement work in inaccessible locations. Nut retainers and channels in this series are of Type 321 stainless steel.

Thread sizes available are 6-32, 8-32, 10-32 and ¼-28. These sizes with the exception of 6-32 also are available in the gang channel nuts. Elastic Stop Nut Corp. of America, 2330 Vauxhall Road, Union, N. J.

For more information—
Circle 3, inside back cover

Battery for Up to 20 Years

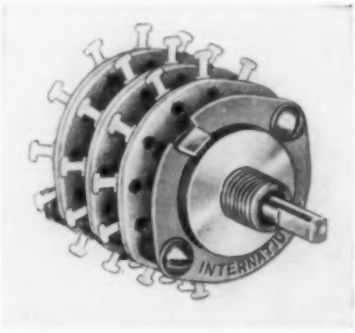
Since this nickel-cadmium battery is hermetically sealed, no damaging fumes or liquids are given off in normal operation and it performs in environmental temperatures ranging from −40 F to 160 F. Peak discharge rates up to 20 times capacity are permissible, and the batteries may be stored indefinitely in any state of charge or discharge. Sizes from 0.8 amp-hr are available. Saft Corp. of America, Gregg St., Lodi, N. J.

For more information—
Circle 4, inside back cover

Twelve-Position Rotary Switch

A line of low-current, subminiature rotary switches 1.16 in. dia, including contacts, are designed for use on electric and electronic testing equipment, miniaturized and transistorized devices, and other applications where space is limited. Standard contact arrangements from single-pole twelve-positions to four-pole, three-positions are offered; all have positive indexing with 1½-in. torque. One, two or three decks can be supplied with continuous rotation with single-pole or stops for multi-pole operation.

The wafers in these switches are of an impregnated glass melamine which is said to have high humidity resistance. Wafer contacts are silver-



plated and double-wiping for low contact resistance and self-cleaning for long life. Solder-type lugs are used on the wafer's connection ends for ease in wiring. One-piece rotor-contact construction minimizes resistance and chance for failure from corrosion. Rotor contacts are silver alloy supplied in either shorting (make-before-break) or non-shorting (break-before-make) types. The detent mechanism has a single moving part.

Mounting is by means of a ¼ in.,

CONTINUED ON PAGE 226

The Engineer from Continental Screw Co. ...

... is specially trained to analyze your special fastener needs

Continental Screw leads entire industry in production of special fasteners

Continental is the only screw manufacturer that requires every engineer to have specific experience in the production of ground thread taps and gages. Continental knows that special training in this exacting field is necessary to give each job the skill and understanding it requires.

As a result of this specialized training, Continental produces more special fasteners than any company in the field. Over 6,500 different blueprints are turned out each week by Continental engineers. And the degree of accuracy is so great that Continental cold-forged fasteners are daily replacing expensive screw machine products, improving the product by increasing its strength while reducing its cost.

Why not put your special fastener needs in the most experienced hands. Continental's specially trained engineers are always ready to analyze your particular fastener needs. Call Continental today.

CONTINENTAL SCREW COMPANY INC. 1904

You Can Always Count on Continental

Continental Screw Co.

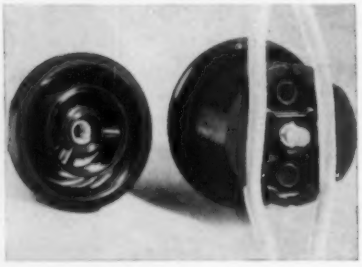
Manufacturers of Holtite Fastenings

New Bedford, Massachusetts, U.S.A.

No. 32 threaded bushing, ¼ in. long. Standard, pointer-type black plastic knob, mounting washers and hex nut are provided. Maximum panel thickness is ⅛ in. Overall depth of the switch behind panel is 0.600 in. for the single-deck type to 1.160 in. for the three-deck model.

Contact resistance is 0.015 ohm; dielectric strength, 1000 v, rms, min; insulation resistance, 100 megohm min; current-carrying capacity, 1 amp at 50 v, dc; current breaking capacity, 250 ma at 50 v, dc, or non-inductive a-c load. International Instruments, Inc., P. O. Box 2954, New Haven 15, Conn.

For more information—
Circle 5, inside back cover



Insert Requires No Tapping

This thread insert is pushed into a straight-sided, plain hole to provide female threads in non-structural parts. The hole can be drilled, molded or die cast.

Tooling consists of a mandrel. The mandrel may be used in any device with a suitable stroke for pushing the insert into the hole, such as a drill press, kick press, arbor press or air piston. Rotation is not required.

The insert is recommended for plastics, zinc die castings, permanent mold and sand casting alloys, wrought, die cast and cast aluminum alloys, lead base casting alloys, soft copper-base alloys and ferrous metals under certain conditions. The new insert is manufactured from wire coiled into a helix.

When the screw is turned into the threads provided by the insert, a run-out thread on the screw automatically wedges the top coil of the insert into the parent material which securely anchors it. In the case of light metals, a simple staking operation may be used as an alternate method of anchoring. The insert can also be installed from the back, in the case of through-holes, to press against a retaining shoulder.

The new push-insert is available as standard in copper-clad steel but is also available in phosphor bronze, cadmium-plated steel and other materials. Heli-Coil Corp., Danbury, Conn.

For more information—
Circle 6, inside back cover

Voltage-Sensing Rectifiers

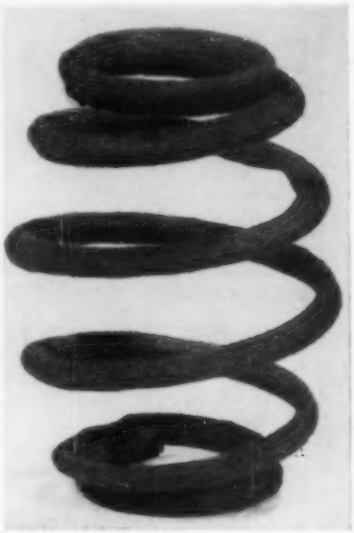
These rectifier units automatically increase the output voltage as the load or current demand is increased. Developed for automatic plating operation, use can be extended to other applications where a greater degree of constant current density is required.

The amount of voltage increase with increasing load may be varied by a simple control which is preset. In automatic program plating, during a fully automatic plating cycle, and as succeeding racks are added to the solution (increasing load), the voltage requirement increases in order to maintain a required current density in all the work. At the end of a plating period the voltage automatically decreases to prevent excessive current density or burning of the remaining pieces of work. Rapid Electric Co., 2881 Middletown Road, New York 61, N. Y.

For more information—
Circle 7, inside back cover

Wick-Covered Spring Carries Lubricant

A barrel-shaped coil spring 2½ in. long and designed to compress to a solid height of ⅞ in. is covered with an absorbent tubular wick. Designed for use in die sets, these springs are reversible and worn portions of wick may be pulled forward and cut off as it becomes worn. It is reported that these lubricant-carrying covers can be



stretched as much as 25 per cent without serious effects. William V. Heinz, P.O. Box 455, LaSalle, Ill.

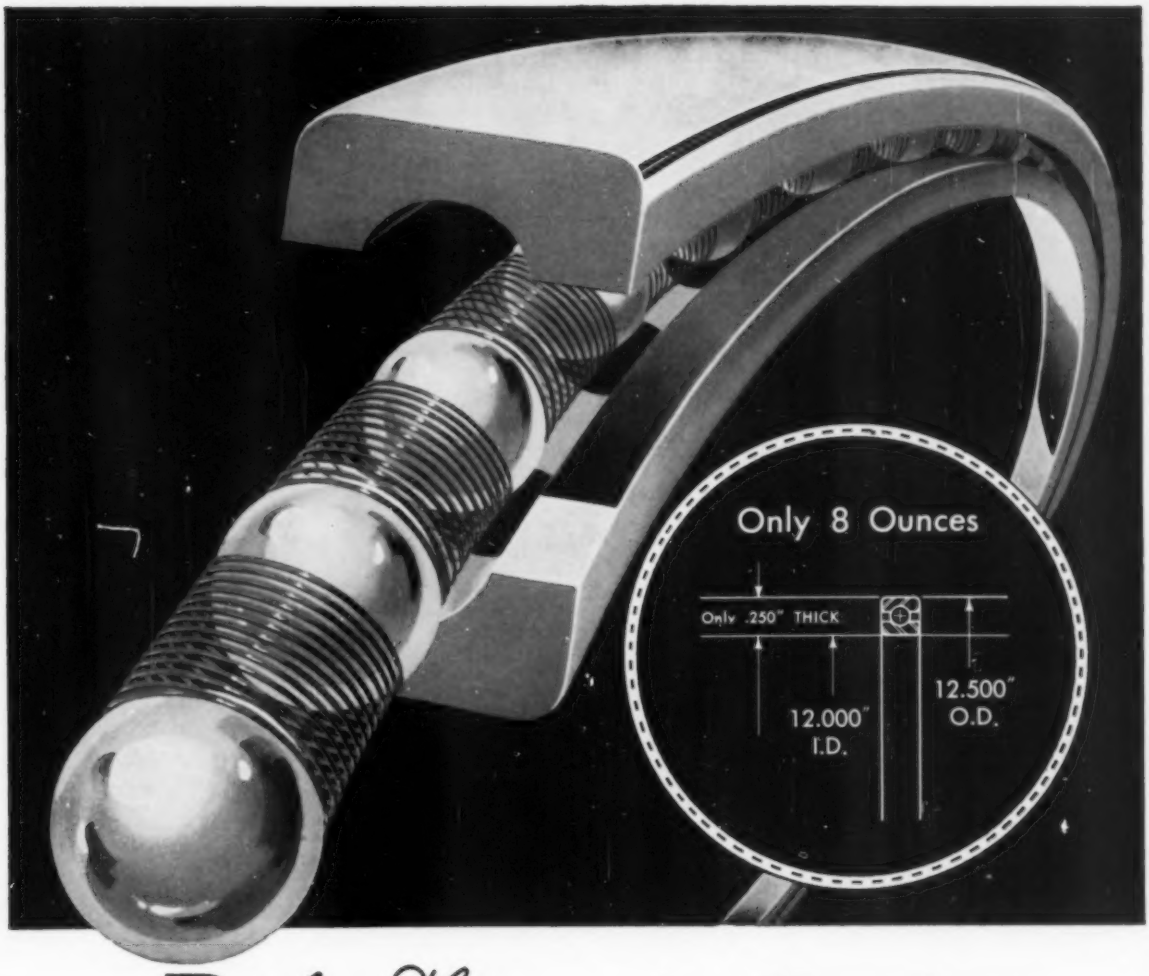
For more information—
Circle 8, inside back cover

Miniature Gearing

A line of precision miniaturized gears are now available for delivery within 30 days or less. These gears offer the following tolerances and characteristics: tooth to tooth composite tolerance, 0.0003 in.; total composite tolerance, 0.0005 in.; journal diameter tolerance, ±0.0001 in.; burnished gear teeth and burnished bearing diameters; 20-deg pressure angle; 80, 96, or 120 diametral pitch.

Hardened stainless steel, brass, aluminum and other materials are available. Gears with closer tolerances, different pressure angle and pitch available on special order. AGMA

CONTINUED ON PAGE 228



Reali-Slim... by Kaydon
world's thinnest radial ball bearing

HERE'S a typical example of Kaydon's *Reali-Slim* unique radial ball bearing that's finding wide application in practically every industry. *Reali-Slim* are the world's finest thin-section bearings and proportionately are thinner than a wedding ring. The bearing illustrated here is 12.000" I.D., 12.500" O.D., .250" thick — weighs less than 8 ounces. Designed for minimum weight and space limitations, it has a static load capacity of 5,520 lbs. and 894 lbs. at 100 rpm.

If you're looking for *Reali-Slim*, lightweight, radial ball or roller bearings, look at Kaydon's *Reali-Slim* line. Besides hundreds of standard *Reali-Slim* designs, there's a wide variety of special races, seals and separators to meet special bearing problems. What's more Kaydon is able to produce these *Reali-Slim*, high-precision bearings because Kaydon specializes in the unusual. In addition, Kaydon bearing engineers are prepared to give you valuable help with technical bearing application problems.

For complete data on *Reali-Slim* bearings for standard or special applications, ask for engineering Catalog No. 54RS-2.

***Reali-Slim* Ball Bearings** — in Conrad, angular contact, 4-point contact and other types are available in seven standard cross sections from .250" to 1" and in bore diameters from 4" to 40".

***Reali-Slim* Roller Bearings** — in radial or taper roller types are available in cross sections from 3/16" and in bore diameters from 5" to 40".

K-554

THE KAYDON ENGINEERING CORP.
MUSKEGON • MICHIGAN

All types of ball and roller bearings — 4" bore to 120" outside diameter . . .
Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Spherical Roller • Ball Radial • Ball Thrust Bearings

standards used throughout. Washington Machine & Tool Works, Inc., 1001 Washington Ave., S., Minneapolis 15, Minn.

For more information—
Circle 9, inside back cover

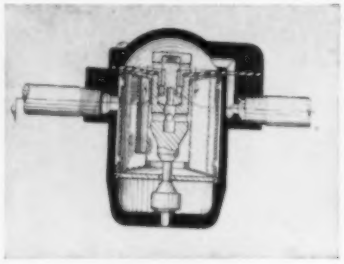
Miniature Sampling Switch

Rotary sampling switches with integral d-c drive motor for use in airborne and general instrumentation applications has a phasing arrangement between poles that can be manually adjusted while the switch is in operation. This switch is available with one, two, three or four poles containing 24, 30 or 32 shorting (12, 15, or 16 non-shorting) contacts per pole. Motor voltages of 6, 12, or 27.5 v, dc, at sampling speeds ranging from 0.1 to 10 revolutions per sec can be provided. Applied Science Corp., Princeton, N. J.

For more information—
Circle 10, inside back cover

Self-Adjusting Air Filter

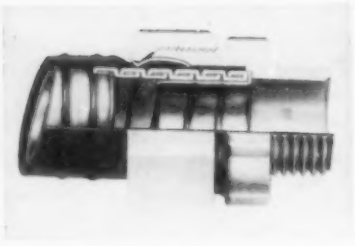
This filter operates by differential of pressure. As the air flows through the unit, moisture, rust, grit, sludge and other abrasive substances with a specific gravity greater than air collect in the main filter chamber of the unit. Sudden stoppage of the air flow causes the internal valve to change position. During this brief instant, the water and foreign substances collected are jettisoned through the opening at the bottom of the separator. This process is repeated each



time the air is released and stopped.

The unit has a range of from 1 to 20 cfm. Its operating range is from 60 to 250 lb air pressure. Weight is 12 oz. Emco Pneumatic Corp., 1317-1319 Locust St., Des Moines, Iowa.

For more information—
Circle 11, inside back cover



Fitting for Liquidtight Conduit

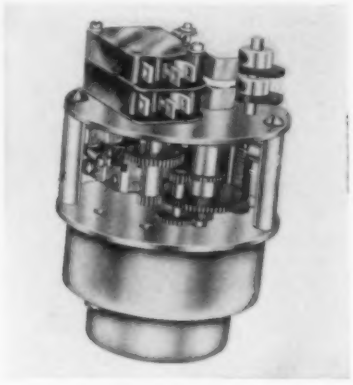
Sealing action is achieved through the use of a brass sealing ring, which is an integral part of the connector and is never removed. Tightening of the nut compresses and coins the brass sealing ring into the body and nut to provide a solid mass.

The new connector is being manufactured in a complete range of sizes for straight, 45 and 90 deg connections. Electrical Fittings Corp., 37-50 57 St., Woodside 77, New York.

For more information—
Circle 12, inside back cover

Time-Delay Relay

This time-delay relay is powered by a solenoid-operated differential-type movement. Delays are available in an extremely wide time range. This unit can be provided with various switch combinations and is also available as a clutch-type motor.



The approximate dimensions of the unit are 3 x 2¾ in. dia. The timer pictured is designed for 115 or 220 v, 60 cps operation. Units for other voltages and frequencies can be provided. Bristol Motor Div., Vocaline Co. of America, Inc., Old Saybrook, Conn.

For more information—
Circle 13, inside back cover

Clutches for Heavy Duty Equipment

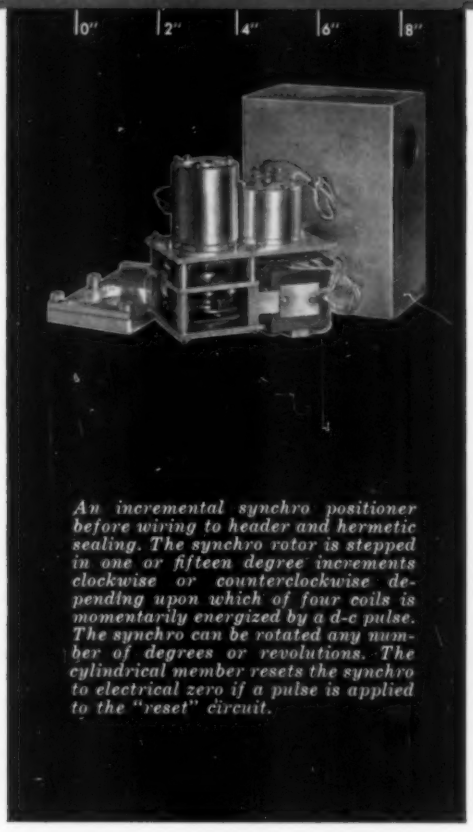
The clutch plates used in these clutches are said to be suited for heavy duty machines such as tractors, trucks, cranes, shovels, bulldozers, tanks, earth movers, graders and other heavy machines. Field tests indicate up to 100 percent more torque capacity and permit the use of smaller diameter, less expensive units. Less lever or pedal pressure is required for engaging and disengaging.

Work life of the clutches has been increased as much as 400 percent, cutting down time for adjustments or

CONTINUED ON PAGE 230

built to do just one servo control job . . .

perfectly



An incremental synchro positioner before wiring to header and hermetic sealing. The synchro rotor is stepped in one or fifteen degree increments clockwise or counterclockwise depending upon which of four coils is momentarily energized by a d-c pulse. The synchro can be rotated any number of degrees or revolutions. The cylindrical member resets the synchro to electrical zero if a pulse is applied to the "reset" circuit.

Like all Transicoil servo assemblies, this incremental positioner "does the job right" because it was designed for a single application . . . by a company whose major function is to provide complete servo assemblies precisely engineered and manufactured to solve individual servo control problems.

Of course, if you merely want servo *components*, you'll find Transicoil's control motors, motor-gear train combinations, motor-gear train-generator combinations, and servo amplifiers built to the highest order of precision and accuracy. But it is in the "package" engineering of unique assemblies that Transicoil's experience and creative imagination offer the greatest value. And in most cases, these assemblies cost no more than the individual components would purchased separately.

That's why it pays to check your servo problems out with Transicoil first. Write outlining your problem, and ask for Transicoil's new gear-motor bulletin. You'll find it a mighty handy availability guide in designing for tight production schedules.

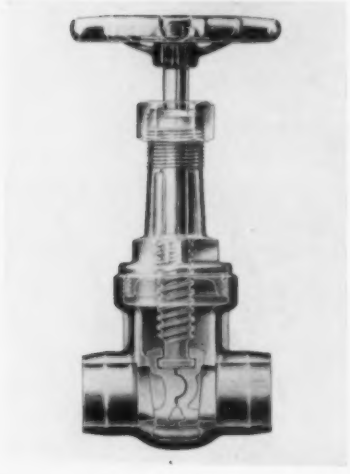
Transicoil

CORPORATION

Worcester • Montgomery County • Pennsylvania

replacements to one-fourth. Heat dissipation has been improved to the extent that excessively burned or warped clutch plates have been eliminated. Torque does not fade as heat increases. Rockford Clutch Div., Borg-Warner Corp., 1301-18th Ave., Rockford, Ill.

For more information—
Circle 14, inside back cover



Bronze Solder End Valves

The line includes three gate valves —rising stem with double-wedge disc, rising stem with solid-wedge disc, and non-rising stem with single-wedge disc. All three are rated at 125 lb steam pressure and 200 lb water, oil or gas. A bronze swing check valve with renewable disc and side plugs carries the same pressure ratings. The line is completed by a non-metallic disc globe valve, rated at 150 lb steam and 300 lb water, oil and gas. Lunkenheimer Co., P. O. Box 360, Cincinnati 14, Ohio.

For more information—
Circle 15, inside back cover

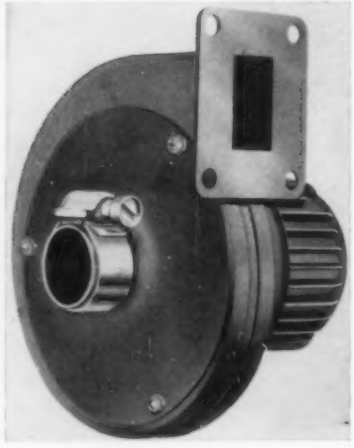
Totally Enclosed Fhp Motors

This spraytight, totally enclosed motor is built with varnish-impregnated windings and cords, corrosion-resistant hardware and solidly welded steel base. Recommended for nearly all marine auxiliaries above and below decks, the motor meets all design and material requirements for Service "C" motors under specifications MIL-M-17556, according to the manufacturer.

The motor has double-sealed, double-width, single-row ball bearings. One bearing is locked on the shaft; the other bearing is locked on both the shaft and in the housing for minimum end play.

The motors are available with speeds of 3450, 1725, and 860 rpm and ratings of 1/20 through 1 hp. Starting torque is rated in excess of 200 percent of full-load torque, and starting current is about 500 to 1000 percent of full-load current. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 16, inside back cover



Centrifugal Blower

This radial wheel, centrifugal blower is recommended for use in applications requiring a high pressure-to-volume cooling performance. It is particularly suitable for operation at high shaft speeds, obtainable with 400 cps power supplies.

Weighing approximately 3 lb, the unit is capable of moving 25 cfm at 11,000 rpm. Can operate either on single or three-phase, 60 cps and 400 cps power. Rotron Mfg. Co., Schoonmaker Lane, Woodstock, N. Y.

For more information—
Circle 17, inside back cover

Small Relay for Heavy Current

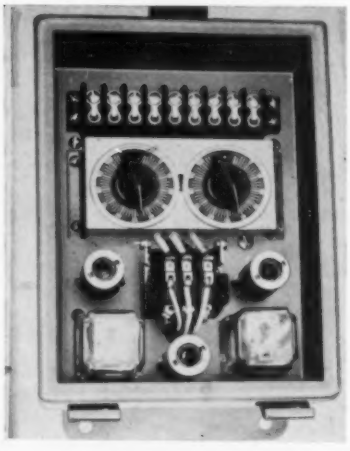
The single-pole, single-throw, normally open, double-break contacts in this relay can switch up to 20 amp, non-inductive load. Overall dimensions are $1\frac{5}{8}$ x $\frac{13}{16}$ x $1\frac{7}{16}$ in. height. Minimum coil operating power is $\frac{1}{2}$ w.

The new relay is available for d-c operation up to 150 v. Other relays with similar heavy duty contacts are available for operation from alternating current. Magnecraft Electric Co., W. Grand Ave., Chicago 51, Ill.

For more information—
Circle 18, inside back cover

Adjustable Electronic Timer

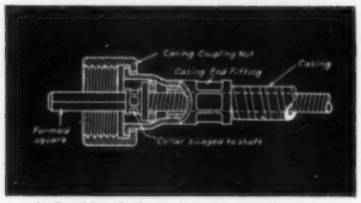
Independently adjustable on and off time ranges are provided in an electronic timer designed for use on life test equipment, proportioning controls and process or machine applica-



—CONTINUED ON PAGE 232

FLEXIBLE SHAFT IDEAS for ENGINEERS

Integral drive squares offer many advantages



A flexible shaft and casing combination with an integral drive square on the shaft.

THE integral drive square is formed by swaging the end of a flexible shaft into an accurate square. Used with broached or swaged square hole in the connecting member, the integral drive square is a simple, positive drive connection which can be used on either remote control or power drive flexible shafts.

Its use saves the cost of a machined end fitting and permits the use of a smaller, close fitting outer casing, two factors which lead to a reduction in the cost of the flexible shaft combination.

If you are now using flexible shafts or if you're working out a flexible shaft application it will pay you to investigate the possibilities of flexible shafts with integral formed drive squares.

S. S. White engineers offer valuable technical help

TAKE advantage of the advice and assistance of S.S.White engineers in working out details of your flexible shaft installation. They can save you time and money by recommending the most economical installation for your specific conditions.

There is no cost or obligation for this service. It enables you to get the benefit of S.S.White's long experience in the design and application of flexible shafts to all types of service.

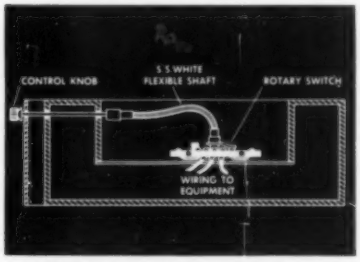
All details, of course, are held in strictest confidence.

Flexible Shafts are the key to many remote control problems

Space, operating and servicing requirements are readily met with S. S. White Metal Muscles®

MANY kinds of equipment contain internal elements which require more or less frequent adjustment from the outside. This comes under the heading of remote control.

There are various ways by which remote control can be accomplished. The simplest, of course, is to mount the element requiring control on the inside of the equipment case or housing with its shaft extending through for manual or automatic operation.

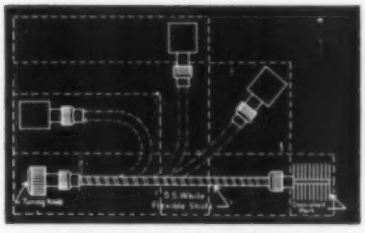


A flexible shaft used to control an inaccessible rotary switch. Note the 90° turn.

Flexible Shaft Simplicity

However, such direct connection is frequently not feasible. Factors of space, circuit efficiency, ease of assembly and of servicing must be considered. This applies also to the selection of the method of control to use.

An S.S.White Remote Control Flexible Shaft makes it possible to satisfy these requirements in an extremely simple manner. In place of comparatively complicated gearing, universal joints and similar contrivances, a single self-contained, easily applied flexible shaft does the trick.



Meeting varying space requirements is easy with a flexible shaft.

Design Freedom

But simplicity is only one advantage the flexible shaft offers for remote control. Perhaps its most valuable advantage is the freedom it gives the designer in locating the controlled element and its control knob or dial.

The flexible shaft permits the former to be placed wherever desirable to secure top equipment efficiency, ease of assembly, space saving and convenient servicing. At the same time it allows the control to be mounted in the most convenient operating position.

Another big advantage is the fact that it eliminates the need for accurate alignment of connected parts.

FLEXIBLE SHAFT DATA

Bulletin 5601 has concise information on how to select and apply flexible shafts. Send for a copy.

FS-1

S.S.White

FIRST NAME IN FLEXIBLE SHAFTS

S. S. WHITE INDUSTRIAL DIVISION, DEPT. D, 10 EAST 40th ST., NEW YORK 16, N.Y.

Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.

tions requiring on-off timing cycles. This timer has double-pole double-throw contacts rated at 20 amp, 115 v, ac, non-inductive load. Circuit employs cold cathode tubes requiring no warm-up time before use. Accuracy is ± 1 percent and independent of line voltage fluctuations from 105-125 v.

Standard available ranges are 0.3 to 25 sec per section and 0.5 to 50 sec per section, with other combinations available. Ferrara, Inc., 8106 W. Nine Mile Rd., Oak Park 37, Mich.

For more information—
Circle 19, inside back cover

Rotary Table Has Air-Hydraulic Indexing

This device holds and delivers small parts to drill, tap, swage, stake and other operations in 8, 12 or 24 stations, accurate to 0.003 in. It will index slow or fast, up to 2800 per hour. The standard dial plate is 12 x ½ in. thick ground steel. Tables up to 20 in. can be handled. Mead Specialties Co., Dept. *FFT-44*, 4114 N. Knox Ave., Chicago 41, Ill.

For more information—
Circle 20, inside back cover

Miniature Linear Transducer

A transducer senses linear motion, position, displacement and vibration in a temperature of 160F to 1300F, without cooling or other protection. Utilizing the principal of variable permeance, the sensing element works as part of an a-c bridge circuit and is usable with most carrier equipment.

Mounting diameter is 0.50 in. All exposed surfaces are stainless steel. Enlarged view of end shows three silver welding studs used for electrical connections. Linear ranges from 0.2 to 4 in. are available.

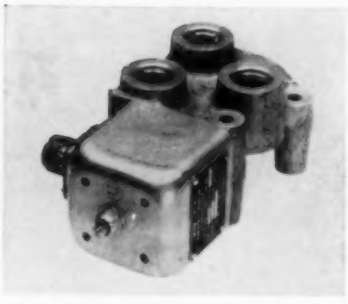
All models have resolution of 0.000 0001 in. Operating sensitivities are from 0.1 to 3 v per in. Linearity from 1.5 to 0.3 percent over linear range. Crescent Engineering and Research Co., 11632 McBean St., El Monte, Calif.

For more information—
Circle 21, inside back cover

Deposited Carbon Resistors

These resistors are made in a range of standard RETMA ohmage values and are produced in 1/20, 1/10, ¼, ½, ½, 1 and 2-w sizes. Standard tolerances are 2, 5 and 10 percent. Electroseal Products, Inc., 22 E. 40 St., New York 16, N. Y.

For more information—
Circle 22, inside back cover



Three-Way Solenoid Valve

These three-way valves are in stock for assembly and shipment within 24 hr after receipt of orders. A wide variety of configurations can be supplied.

Tube sizes from ¼ to ½ in. are available. Some of the other features are low current drain, continuous duty operation, fast action, explosionproof operating range 0-5000 psi, temperature range −65 F to 275 F and flow rates up to 10 gpm. Mar Vista Engineering Co., 5420 W. 104 St., Los Angeles 45, California.

For more information—
Circle 23, inside back cover

Shaded Pole, Fhp Motor

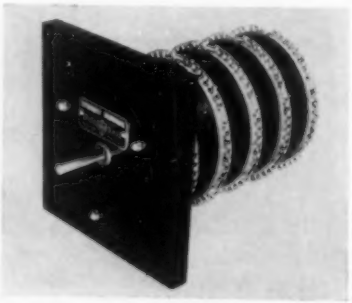
This motor is available in ratings from 1/500 to 1/80 hp at speeds from 1200 to 1550 rpm. It is designed to operate from 32 to 120 F.

With recommended lubricants it will operate at full ratings to −40 F. The motor is supplied for 60 cps operation at 115 or 230 v. Five types of mounting brackets are available. Morrill Motors, 3100 Fairfield Ave., Fort Wayne, Ind.

For more information—
Circle 24, inside back cover

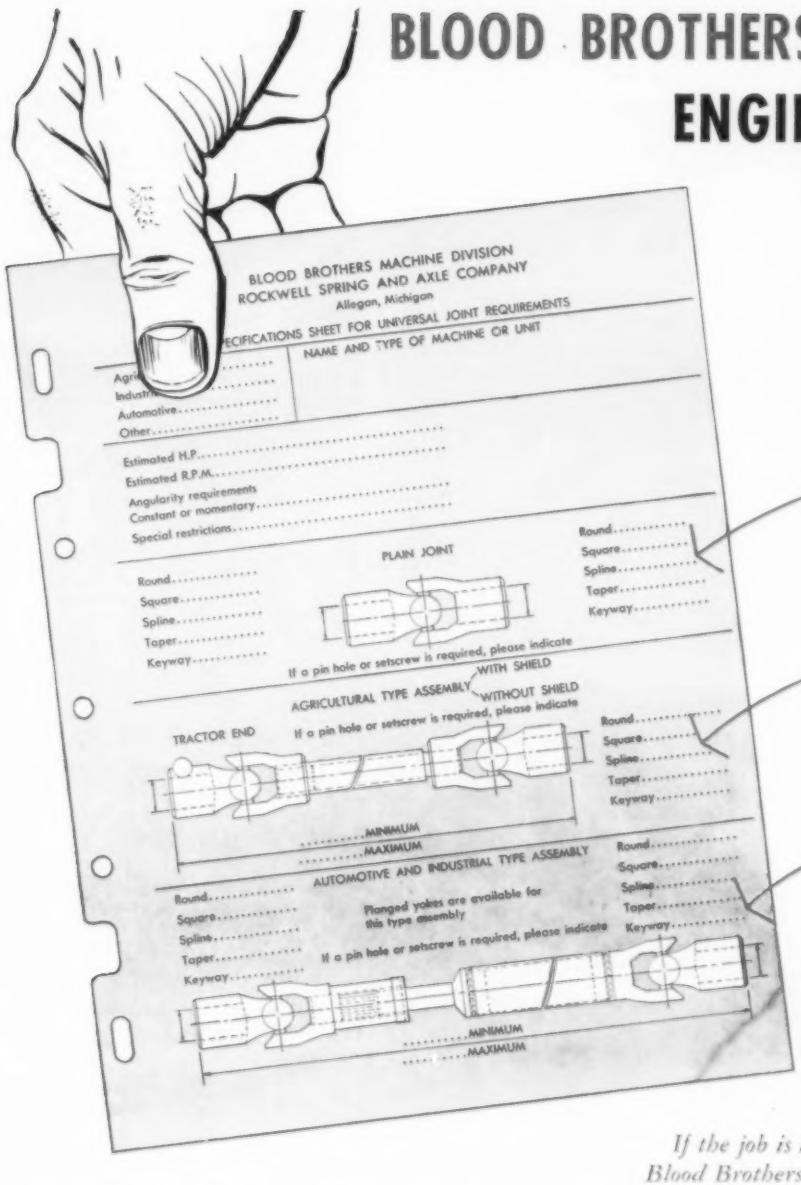
Low-Level, High Speed Sampling Switch

A thermocouple or strain gage, high speed sampling switch, this unit has five poles with 90 contacts per pole. The average dynamic contact resistance is approximately 1 ohm. The unit is approximately 6¼ x 3⅝ in. dia, plus mounting bracket. Available models include single or multiple-pole units featuring stacked, opposed, con-



CONTINUED ON PAGE 234

BLOOD BROTHERS makes your ENGINEERING JOB *EASIER*



. . . regardless of whether your project requires a single universal joint such as this

. . . a complete agricultural type assembly

. . . or an automotive or industrial truck propeller shaft like this

Just fill out and mail a sheet like *THIS*—and let BLOOD BROTHERS' Engineers propose a helpful, practical solution to your Drive Line Problem!

If the job is unusual or the problem unique, Blood Brothers' experience can be invaluable.

Many engineers are saving valuable time—right at the start of a project—by filling out and returning a "Spec Sheet" like this to Blood Brothers. Why not try it?

With your power transmission requirements in mind, our engineers will make recommendations and submit engineering drawings. You save designing and drafting time, and perhaps forestall problems, by having the initial teamwork of experienced specialists.

This service is offered without extra charge because *we* can work more efficiently with all the facts in hand.

Blood Brothers builds *more standard types and sizes* of universal joints than any other manufacturer (from 300 up to 89,300 torque inch pounds continuous load).

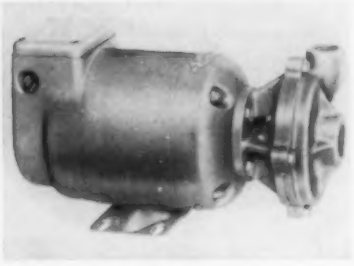
Why not use this experience on your next project? *Write Blood Brothers today for your handy "Spec Sheets."*

BLOOD BROTHERS MACHINE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

centric, raised contact, segmented, and/or printed circuit designs. General Devices, Inc., P. O. Box 253, Princeton, N. J.

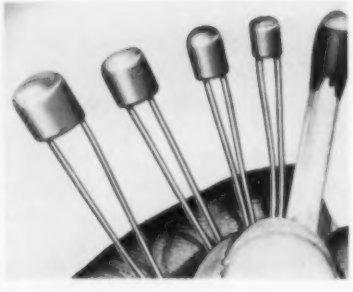
For more information—
Circle 25, inside back cover



Centrifugal Pump

This 1/20 hp pump, equipped with self-adjusting, pre-tested seal, is designed for use in closed, semi-closed or open systems and can be mounted either in a horizontal, vertical or angular position. The discharge relation is interchangeable in four 90 deg positions. The pump is available in cast iron or bronze. Ruthman Machinery Co., Cincinnati 2, Ohio.

For more information—
Circle 26, inside back cover



Subminiature Selenium Diodes

Type 6UI is rated for a maximum input of 156 v, rms, Type 7UI for 182 v, rms, and Type 8UI for 203 v, rms, at 1.5 ma. These diodes are designed for stable operation in an ambient temperature range of −50 C to 100 C. International Rectifier Corp., El Segundo, Calif.

For more information—
Circle 27, inside back cover

Photoelectric Counter

The counting eye comes assembled, equipped with cords, completely wired, adjusted and ready to use. Counting is afforded at distances up to 8 ft, between the eye and light source. Each object to be counted should interrupt the light beam $\frac{1}{16}$ sec or more, and space following each object should permit restoration of the light beam for $\frac{1}{16}$ sec or more.

Case is of cast aluminum, gasket-sealed and tapped for $\frac{1}{2}$ in. conduit. Dimensions of counting eye and light source are the same; height, $5\frac{3}{4}$ to $6\frac{1}{4}$ in. depending on bracket adjustment; width, $3\frac{1}{16}$ in., depth, less bracket, $3\frac{13}{32}$ in. Autotron Co., Box 722-V, Danville, Illinois.

For more information—
Circle 28, inside back cover

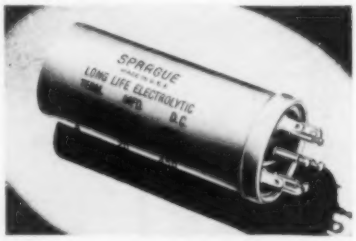
Snap-Action Thermostat

A bimetal disc thermostat designed for such application as clothes dryers and furnace ducts is U L listed and approved for operation to 300 F, according to the manufacturer. These thermostats are rated at 25 amp at 120-240 v, ac, non-inductive; $\frac{1}{2}$ hp at 120-240 v, ac; and 345 va for pilot duty. Two basic styles are available: either exposed bimetal or enclosed bimetal. Stevens Mfg. Co., Inc., Lexington and Mansfield, Ohio.

For more information—
Circle 29, inside back cover

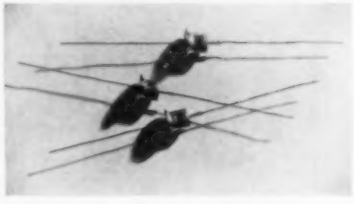
Electrolytic Capacitors

Nineteen standard ratings covering a wide range of applications in single, dual, and triple section units are available in this series. All said



to be characterized by low maximum leakage current and remarkable life test capabilities. Sprague Electric Co., 195 Marshall St., N. Adams, Mass.

For more information—
Circle 30, inside back cover



Germanium Power Diodes

Designed for use in high level modulation and detection in communications and control, audio frequency switching applications and rectification in the power range up to 25 w, this line of diodes provides peak inverse voltages up to 300 v. Peak forward currents up to hundreds of milliamp are possible. Clevite Corp., 241-257 Crescent St., Waltham 54, Mass.

For more information—
Circle 31, inside back cover

Miniature Differential

These units will combine two rotating inputs to give speed sums or differences and angular sums or differences. They are also ideal for controlling relative speeds, for obtaining exceptionally wide speed ratio between shafts, for shifting phase angles between rotating shafts, and for quickly reversing and changing speeds without disconnecting the power source.

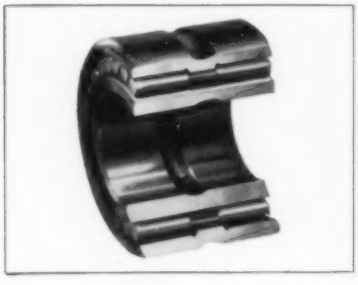
Thirty-four different ratios, from 1:1 to 27:1, provide wide design possibilities. Hobbed and hardened spur

CONTINUED ON PAGE 236

BEARING TIPS by McGill

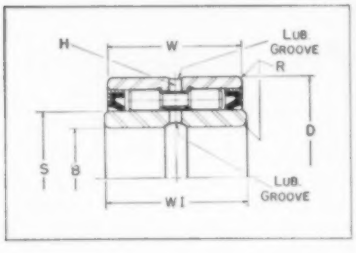
CAGELESS BEARING CORRECTS SKEWING

Guiderol Bearings carry greater loads in smaller spaces because they have no space wasting cages. A full complement of center grooved rollers extends the width of the race for maximum load support and a center guide rail avoids roller skewing that can bind a bearing under some loads. MT and CT series interchange dimensionally with ordinary needle bearings and cylindrical roller bearings.



First Sealed Full Type Roller Bearing Series

The SG series Guiderol bearing provides low-cost and flexible sealing where ordinary needle-type bearings with auxiliary seals have been too cumbersome and expensive. Interchangeable with the standard Guiderol bearing, the new SG series provides five sealing combinations.



140 Pages of Bearing Facts

Write for your copy of Catalog No. 52, a revised 140-page Bearing Selection Guide. It contains vital product information and 30 pages of engineering data.

GUIDEROL® BEARING CARRIES GREATER LOAD IN SMALL SPACE FOR McCULLOCH CHAIN SAWS

Bearings installed in 1944 still in use.

Load-carrying capacity in minimum space is given as the reason for using McGill Guiderol bearings on the heavy-duty loader made by the Farmhand Company. Four bearings support the shafts of the gear pump that furnishes hydraulic power to the loader. Guiderol bearings have been used by Farmhand since 1944 and virtually all of the loaders with the original bearings are still in use.

Assembly ease cited as an extra benefit

Rugged use in the field dictates rugged construction at the factory for McCulloch Motors Corporation gasoline engine chain saw units. The one-man and two-man chain saws must be light and compact but sturdy enough to operate at full capacity all day long.

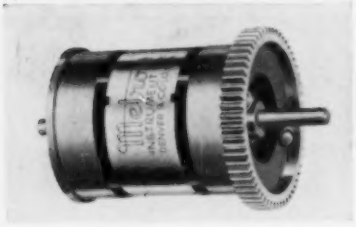
Since switching to a McGill Guiderol Bearing as support for the crankshaft, McCulloch, like many machine builders, has proved that the Guiderol bearing provides the desired greater load capacity in small space and outlasts former units with minimum maintenance—important under rugged chain saw field conditions.

A bonus benefit is the ease of installation of the Guiderol bearing—with open ends and no end shoulders. Assembly is a simpler operation.

Insure performance with McGILL®

MULTIROL® GUIDEROL® CAMROL
Full Type Roller Bearings

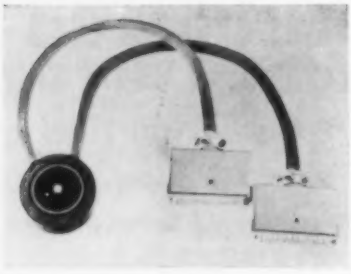
McGILL MANUFACTURING COMPANY, INC., 201 N. LAFAYETTE ST., VALPARAISO, INDIANA



gears give smooth operation. External bearing surfaces are of brass.

Units with an internal anti-backlash feature are available. Anti-backlash results from two parallel gear trains spring-loaded against each other, taking up backlash continuously whether running or not. Metron Instrument Co., 432 Lincoln St., Denver 3, Colorado.

For more information—
Circle 32, inside back cover



High Speed Switches

The line incorporates semi-molded contact plate construction. Each contact pin is permanently locked into precise alignment, affording maximum dimensional stability. Wire leads are permanently molded into the contact plate for ease of connection. Available models include single or multiple pole, stacked, concentric, opposed, raised contact, segmented, or printed circuit designs. General Devices, Inc., P. O. Box 253, Princeton, N. J.

For more information—
Circle 33, inside back cover

Electro-Magnetic Clutches

These clutches meet specification MIL-E-5272 and are available in ratings of 6 to 120 v, dc. They are supplied with a servo-type mounting and

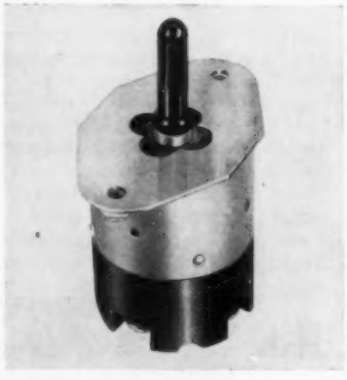
can be used in slip applications for intermittent duty.

Minimum clutch torque ranges from 2 to 90 in-oz; brake torque, 2 to 75 in-oz according to model chosen. Weight also varies: 0.9 to 40 oz. Dimensions 1.968 x 0.810 in. dia. to 3.961 x 2.06 in. dia. A. J. Thompson Co., Route 1, Box 812, Florissant, Mo.

For more information—
Circle 34, inside back cover

Four-Throw Toggle Switch

A heavy-duty toggle switch is announced that is of the momentary—contact four-throw, single-pole, center-off type. It is internally sealed with a silicone boot that keeps moisture and dust away from the contacts. The wiping contacts are reportedly able to continue opening and closing despite pitting and corrosion. Fast make and fast break action is provided. Contacts will not weld under current as high as 200 amp.



The switch is rated at 20 amp inductive (AN 3179), at 28 v, dc, for 10,000 cycles, 15 amp inductive at 28 v, dc, for 50,000 cycles. Mason Electric Corp., 3839 Verdugo Rd., Los Angeles, Calif.

For more information—
Circle 35, inside back cover

Pneumatic Regulators

These devices, designed for pneumatic loading and gaging applications, include pressure regulators, volume boosters and reversing relays. Specifications of a typical regulator, the Series 4000, include five ranges (10,

30, 60, 150 and 250 psi); $\frac{3}{8}$ in. dia supply and exhaust seats; three sizes ($\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$ in.). This regulator is especially suited to such machine applications as welding head pressure control, punch press brake and clutch control, cable and sheet tensioning. Bellofram Corp., Burlington, Mass.

For more information—
Circle 36, inside back cover

Miniature Connectors

A line of miniature quick-disconnect electrical connectors automatically seal before locking and can be visually inspected for correct assembly

CONTINUED ON PAGE 238

In 1,960 separate applications these men specified IPC packings

In the short space of 11 months, January-November 1955, IPC packings were specified for 1,960 varying applications. From a simple water pump to a highly complex retainer seal for an automatic transmission, IPC leather and synthetic packings met every design requirement!

IPC's engineering and laboratory staff analyzed all factors . . . carefully developed compounds and designed seals for each application. This is the attention to detail that ensures better packings . . . better performance.

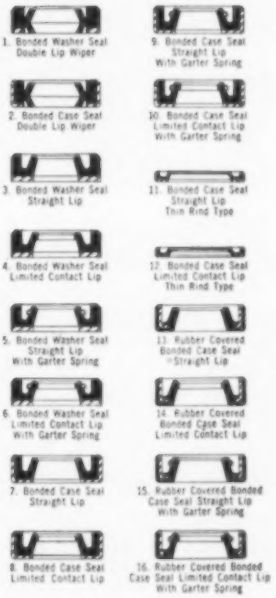
Whatever your problem — specify IPC.

INTERNATIONAL PACKINGS CORPORATION

Bristol, New Hampshire

Branch Offices: Chicago, Dallas, Detroit, Kansas City, New York, Philadelphia, San Francisco, St. Louis.

BONDED BY IPC


1. Bonded Washer Seal Double Lip Wiper
2. Bonded Case Seal Double Lip Wiper
3. Bonded Washer Seal Straight Lip
4. Bonded Washer Seal Limited Contact Lip
5. Bonded Washer Seal Straight Lip With Garter Spring
6. Bonded Washer Seal Limited Contact Lip With Garter Spring
7. Bonded Case Seal Straight Lip
8. Bonded Case Seal Limited Contact Lip
9. Bonded Case Seal Straight Lip With Garter Spring
10. Bonded Case Seal Limited Contact Lip With Garter Spring
11. Bonded Case Seal Straight Lip Thin Rind Type
12. Bonded Case Seal Limited Contact Lip Thin Rind Type
13. Rubber Covered Bonded Case Seal Straight Lip
14. Rubber Covered Bonded Case Seal Limited Contact Lip
15. Rubber Covered Bonded Case Seal Straight Lip With Garter Spring
16. Rubber Covered Bonded Case Seal Limited Contact Lip With Garter Spring

P1

and installation. The connectors are said to have withstood 50 hr of salt spray, temperature operation from −67F to 250 F and continuous dielectric separation with no voids. Receptacle inserts are available in resilient or hermetic-seal types. Deutsch Co., 7000 Avalon Blvd., Los Angeles, Calif.

For more information—
Circle 37, inside back cover

Explosionproof Panel-Mounted Condulets

For panel boards up to 1½ in. thick, these fixtures are firmly secured to the panels by locking nuts on the threaded necks. Condulet bodies in rear of panel are fitted with 1-in. through-feed conduit hubs and large flat ground covers to provide maximum access to interiors.

Condulets are factory-sealed for use with 125-v pilot lights only, with one, two, or three lights, on 1⅞ in. centers. Style 2 condulets, requiring external seals, permit any desired combination of pilot lights, pushbutton and/or selector switches, one, two, or three-gang. Crouse-Hinds Co., Syracuse 1, N. Y.

For more information—
Circle 38, inside back cover

Packaged D-c Power Packs

These power packs are designed to be wired into circuits much the same as standard power transformers. They supply d-c power to filaments, relays, vacuum tube plate circuits and devices requiring direct current in the range of 6 to 350 v and 0.3 to 8.5 amp. Model 3150 operates on 115 v, ac, 60 cps, single-phase, and furnishes 28.5 v, dc, at 1.0 amp with a maximum ripple of 1 percent. Voltage regulation from 1/10 load to full load is approximately 13 percent. Ratings are for continuous duty at 35 C ambient.

The Model 3150 occupies 4¾ x 5⅞ in. of chassis space. Input and output connections are made to solder-hook terminals in compression type multiple headers. Opad Electric Co., 69 Murray St., New York 17, N. Y.

For more information—
Circle 39, inside back cover

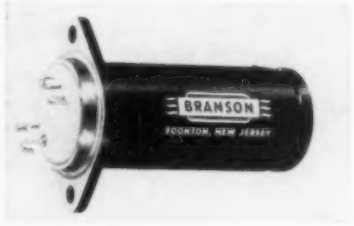
Disconnect for Fuel, Oil Lines

This self-sealing coupling converts any connection into a straight-through line. Pressure deck is said to be equivalent to that of a straight tubing section. A free-floating Teflon seal and flow ball combination provides the seal when the disconnect is in the uncoupled position. The ball lock also serves as a sight-and-feel indicator, giving assurance that the unit is completely coupled and safetied.

The disconnect is operated by hand and a ⅛ turn is needed to disconnect or connect with system pressures up to 200 psi. The new disconnect has successfully passed all fuel tests, MIL-C-7413A and all 7808 oil tests MIL-C-7413A with intermittent temperatures up to 375 F and continuous temperatures of 250 F. It is available

with all types of configurations, including elbows and flanges. Eastern Aircraft Products Corp., 229 River St., Orange, N. J.

For more information—
Circle 40, inside back cover



Time Delay Relay For Use at 125C

This time delay relay is capable of dependable and repeatable performance in ambient temperatures of 125 C. It is a temperature-compensated thermal unit operating on voltages up to 125 v with time delays available between 1 sec and 1 min. It is hermetically sealed and will withstand the environmental requirements of high speed military aircraft including vibration up to 500 cps. Branson Corp., Boonton, N. J.

For more information—
Circle 41, inside back cover

Push-Pull Low-Level Magnetic Amplifier

This amplifier is designed to amplify the output of low level devices such as thermocouples, strain gages, thermistor bridges, photo tubes or crystal detectors so as to operate an

CONTINUED ON PAGE 240

HOW CMP RESTRICTED SPECIFICATION

COLD ROLLED STRIP STEEL CUTS MATERIAL AND END-PRODUCT COSTS . . .

Putting a stop to troubles with cold rolled strip steel has long been the specialized business of CMP.

By working to restricted specifications for size, characteristics and finish, CMP precision rolling and processing has helped in many ways to reduce slow downs in production with flat rolled steel.

The danger of not having steel with the "working qualities" that will keep up with todays high speed automatic machines can be eliminated. In many cases a CMP restricted specification strip has simplified tooling and stepped up machine speeds 25% or more.

And when the free flow of CMP strip is moving through your equipment without difficulty you'll know why your end-product costs are at the right level — why it pays to always check CMP for the right specification wherever cold rolled strip steel is needed. Your inquiry is invited.

CMP WHERE YOU CAN GET SPECIFIC SPECS. FOR SPECIFIC JOBS

- LOW CARBON
- HIGH CARBON
- Annealed or Tempered
- STAINLESS
- ALLOY
- ELECTRO ZINC COATED

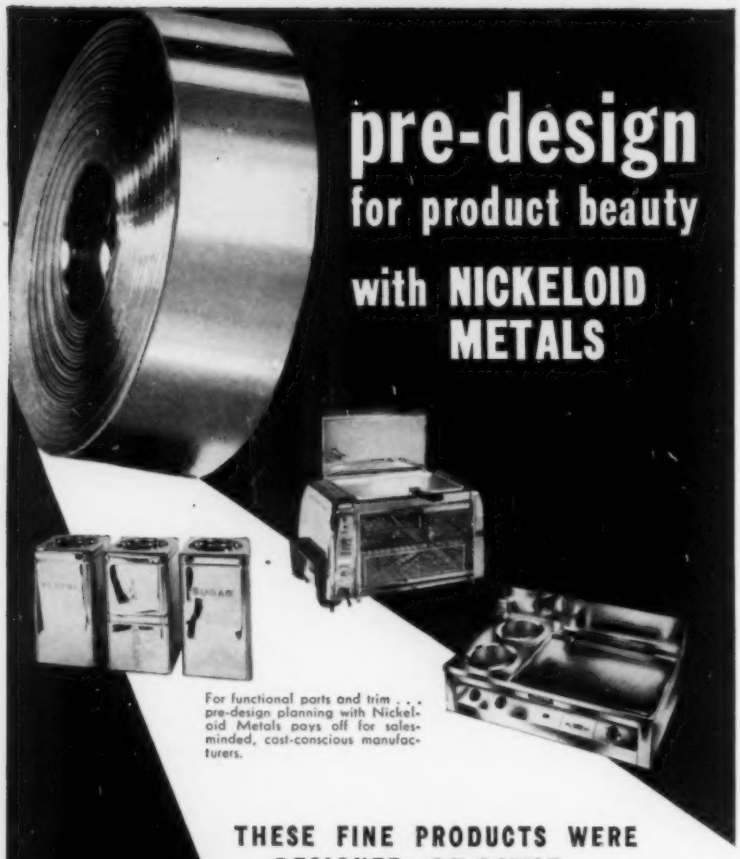
the Cold Metal Products co.

GENERAL OFFICES: YOUNGSTOWN 1, OHIO

PLANTS: YOUNGSTOWN, OHIO AND INDIANAPOLIS, IND.

SALES OFFICES: New York • Cleveland • Detroit • Indianapolis
Chicago • Los Angeles • San Francisco

pre-design for product beauty with NICKELOID METALS



For functional parts and trim . . . pre-design planning with Nickeloid Metals pays off for sales-minded, cost-conscious manufacturers.

THESE FINE PRODUCTS WERE DESIGNED *AROUND* NICKELOID METALS

In the pre-design stage . . . before investing in tools and dies . . . consider pre-plated Nickeloid Metals. Take full advantage of their inspiring design potential and basic production savings, too. PRE-plated in uniform, quality-controlled finishes of chrome, nickel, copper or brass on base metals of steel, zinc, copper, brass and aluminum — Nickeloid Metals require no cleaning, plating, polishing. Just fabricate the parts and assemble. Eliminate 3 out of 5 basic manufacturing steps; save time, reduce costs, increase output.

MAR-NOT PROTECTION

To protect the brilliantly finished surface during drawing and forming operations, and in handling, Nickeloid Metals are available with MAR-NOT — a protective covering that affords absolute protection until final assembly; then may be peeled off. **Write for full details.**

SHEETS • COILS • STRIPS

NICKELOID METALS SINCE 1898

NM

AMERICAN NICKELOID CO.

PERU 4, ILLINOIS

insensitive relay or meter. The amplifier is self-contained and requires no external rectifier.

The amplifier will provide push-pull, d-c output for a reversible polarity d-c signal input. Ambient temperature rating is −55 C to 85 C. Units can be cascaded for increased gain. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.

For more information— Circle 42, inside back cover

Subminiature Toggle Switch

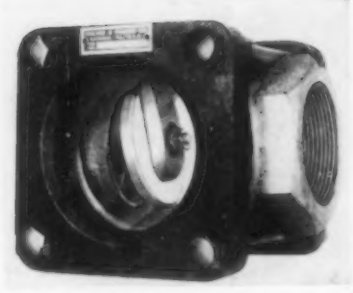
This toggle switch consists of a switch riveted into a stainless steel bracket. The assembly shown is for single-pole, double-throw service. Also available: double-pole, double-throw and triple-pole, double-throw.

The switch unit is approximately ¾ x ⅝ in. thick, and mounts in a

(Continued on page 241)

¼ in. hole. The electrical ratings are: 5 amp at 125/250 v, ac; 3 amp at 30 v, dc, inductive; 4 amp at 30 v, dc, resistive; with a life expectancy of 100,000 cycles, min. Milli-Switch Corp., 1742 Berkeley St., Santa Monica, Calif.

For more information—
Circle 43, inside back cover



Sight Flow Indicator Stops Backflow

A sight flow indicator which combines in the single assembly indication with positive check of back-flow has a self-aligning soft seat flapper which prevents back flow. Two ½ in. thick windows on opposite sides of the body fitting show clearly whether or not there is a flow. The indicator does not measure rate of flow.

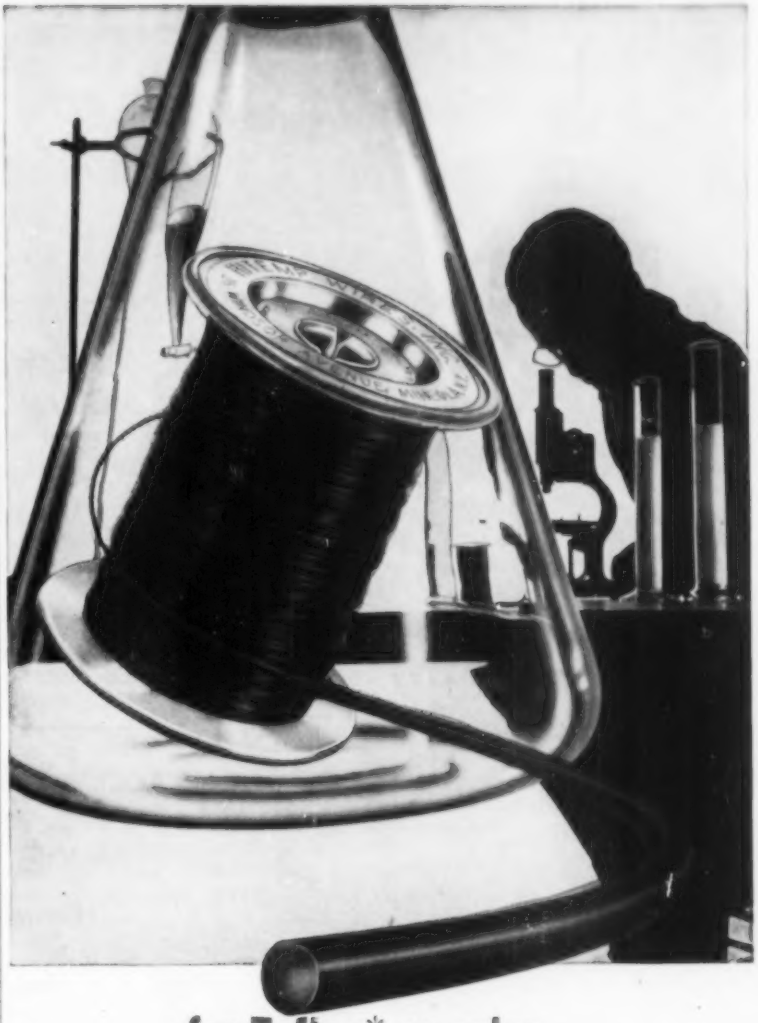
Standard sizes are for 2-in. pipe, with an operating pressure rating of 250 psi, and for 1¼-in. pipe with a rating of 300 psi. Indicator bodies are of bronze or steel and gaskets of Thiokol. Fischer & Porter Co., 544 Jacksonville Rd., Hatboro, Pa.

For more information—
Circle 44, inside back cover

Custom and Standard Springs

Compression, extension, torsion and flat steel springs for automotive, aircraft, electrical, instruments, scientific controls, commercial and general industrial applications are available in custom or standard sizes. A variety of materials including high carbon spring steel, hard-drawn spring steel, oil-tempered spring steel, special valve spring steel, music wire spring steel, alloy spring steel, stainless spring steel, flat spring steel, ribbon spring steel,

(Continued on page 244)



for Teflon* on wire

From advanced know-how and industrial chemistry . . . came "Teflon." Through unique applications of "Teflon" on wire and cable . . . Hitemp Wires, Inc. has opened new horizons for the electronic and electrical industries.

With "Teflon" insulated wire, tubing, multi-conductor cables, lacing cord, tape and sewing thread, miniaturized electronic and electrical components are now possible . . . with the amazing working temperature range of −70°C. to +260°C.

"Teflon" insulated products offer this unexcelled combination of properties: low loss factor, low dielectric constant, high volume resistivity, nonflammable, low coefficient of friction, unaffected by moisture, tough . . . yet flexible, and completely inert to all known commercial solvents.

For better products . . . for lower production costs, call the leading specialist in high temperature insulations . . . your nearest Hitemp Wire, Inc. sales engineer.

HITEMP WIRES, INC.

26 WINDSOR AVE., MINEOLA, NEW YORK

NATIONAL REPRESENTATIVES

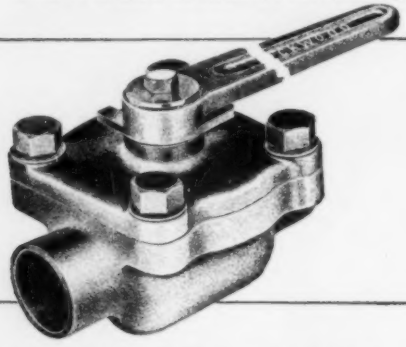
*The Pont's Trade Name for PTFE RESIN DISPERSION

ROCKWOOD BALL VALVES

Perform better...last longer with no maintenance

All Rockwood ball valves have a full *round* port area. This area does not permit the shape of the fluid stream to change, and allows your piping to handle fluids without creating turbulence in the fluid stream, thus reducing friction loss to a minimum.

For complete information on the cost-saving valves below, write Rockwood Sprinkler Company, 808 Harlow Street, Worcester 5, Massachusetts.

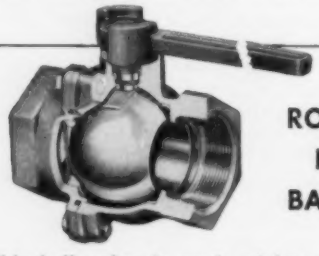


NEW ROCKWOOD TOP ENTRY BALL VALVES

Here's a really unique valve! Four bolts unscrew and the cap of the Rockwood Top Entry Ball Valve lifts to give you easy access to the entire inside — without removing the ball valve from the line! You can change the direction of the flow without removing the valve from the line! Just remove the cap and reverse the cage assembly, that's all there is to it!

New stem design allows the handle to be placed in 8 positions, giving you added convenience in installing and operating the valve.

Made of bronze with interchangeable parts, the Rockwood Top Entry Ball Valve is available with sweat ends or screw ends and in ½", ¾" and 1". It's ideal for handling oxygen and hazardous liquids, as well as water, oil and gas. It carries 300 lbs. per square inch on water, oil and gas and 400 lbs. per square inch on LP gas. Write for complete facts on this unique valve.

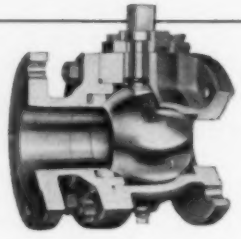


ROCKWOOD BRONZE BALL VALVE

This ball valve is made of bronze with screwed ends in all pipe sizes from ⅜" to 2½" and in cast steel 3" and 4", and is recommended for 300 p.s.i. working pressure.

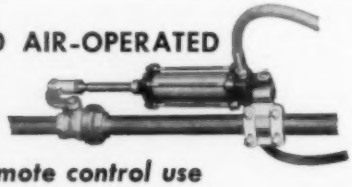
It can be opened and closed with a quarter-turn. Handle design allows valve to be installed in any position assuring clearance in all types of installations. It does not depend upon mechanical parts to maintain proper alignment of ball and seat. Tested and listed by Underwriters' Laboratories, Inc.

ROCKWOOD 3" AND 4" BALL TYPE CAST STEEL VALVES



Made of medium carbon cast steel that fully meets the specifications for carbon steel pressure castings as embodied in ASTM. Rockwood cast steel ball type valves are designed and constructed for superior service. They combine the best features of plug cocks and globe valves. Recommended working temperature 212° maximum.

ROCKWOOD AIR-OPERATED BALL VALVES



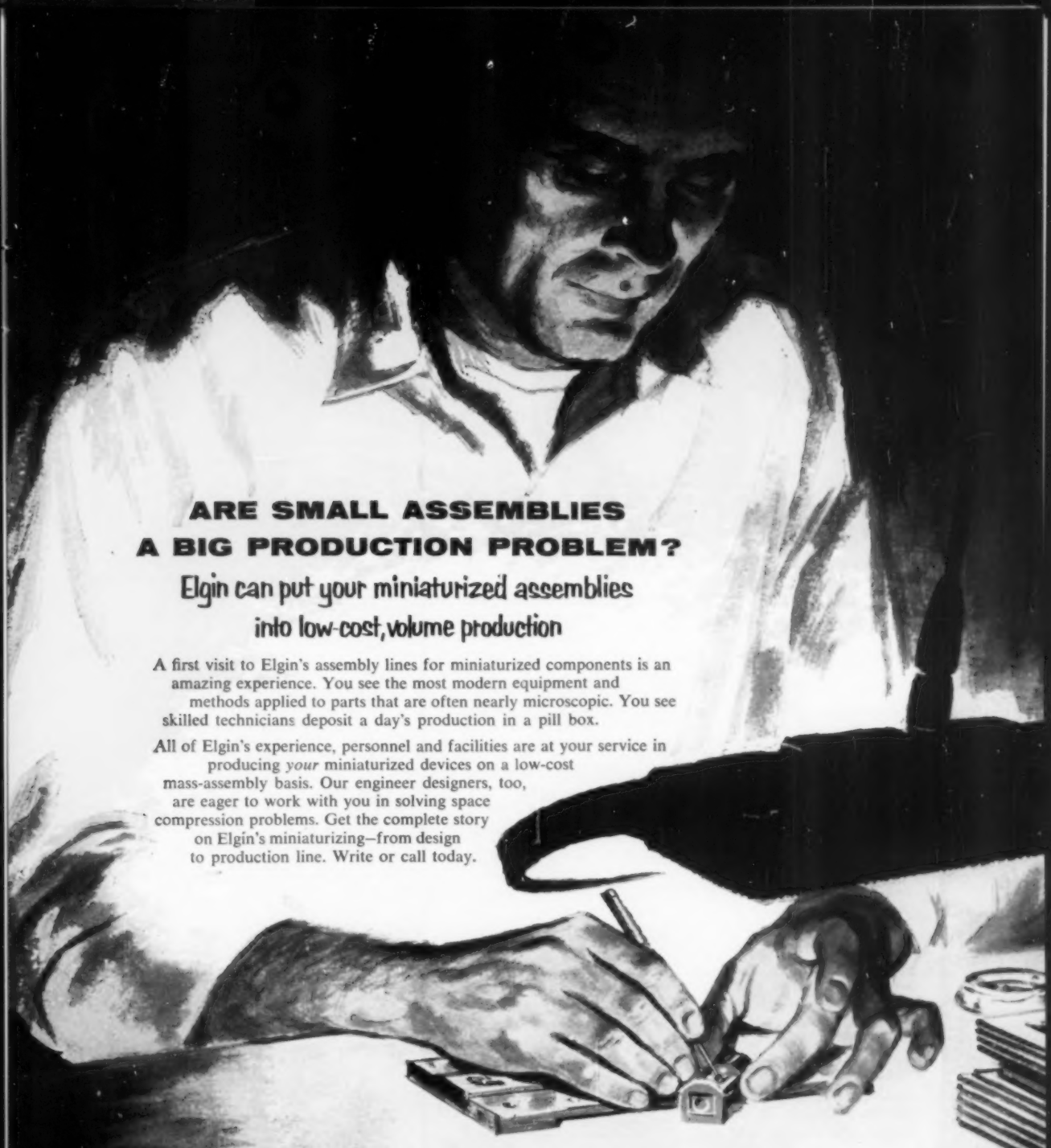
For remote control use

To operate valves in hazardous locations or valves installed in difficult and hard-to-get-at places Rockwood offers you the new air-operated Ball Valve. This new unit can be mounted in FOUR different positions around the Rockwood Ball Valve. It will operate the valve smoothly and efficiently. One valve or several valves can be controlled from one central control board. It is available in a complete package unit — ball valve, cylinder, special handle attachment and mounting bracket. Cylinder, handle and mounting bracket can also be bought separately to be attached to valves already installed on line. Can be operated with various types of controls.

This complete package unit is available in sizes from ½" thru 2" in bronze and 3" and 4" in cast steel. Additional features such as "Fail-Safe" provisions available on request.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW



ARE SMALL ASSEMBLIES A BIG PRODUCTION PROBLEM?

Elgin can put your miniaturized assemblies into low-cost, volume production

A first visit to Elgin's assembly lines for miniaturized components is an amazing experience. You see the most modern equipment and methods applied to parts that are often nearly microscopic. You see skilled technicians deposit a day's production in a pill box.

All of Elgin's experience, personnel and facilities are at your service in producing *your* miniaturized devices on a low-cost mass-assembly basis. Our engineer designers, too, are eager to work with you in solving space compression problems. Get the complete story on Elgin's miniaturizing—from design to production line. Write or call today.

Free Booklet Gives Facts

Write today for "Practical Miniaturization."
Booklet tells how Elgin makes miniaturization practical.

ELGIN NATIONAL WATCH COMPANY

ORDNANCE DIVISION • ELGIN, ILLINOIS

GEAR PROBLEMS? —Check with FAIRFIELD!

IF you use gears in the product you make, we believe it will pay you, as it has others, to become acquainted with FAIRFIELD—the place where fine gears are produced to meet your specifications EFFICIENTLY, ECONOMICALLY! Fairfield's production facilities are unexcelled for making all kinds of accurate, automotive type gears such as are now finding wide use in all branches of industry: for Tractors, Trucks, and Buses . . . for Agricultural Implements . . . for Machine Tools. Ask for latest literature describing Fairfield's facilities. *Your inquiry will receive prompt attention.*

Fine Gears Made to Order

SPUR GEARS—Straight, helical, and internal. Sizes from 16 pitch, 1½" dia., to 1½ pitch, 36" dia.

HERRINGBONE—(*Follows Type*). Sizes from 1½" to 15".

SPIRAL BEVEL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 28" dia.

STRAIGHT BEVEL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 28" dia.

HYPOID—Sizes from 1½" to 28" dia.

ZEROL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 21" dia.

WORMS AND WORM GEARS—Worms to 7" dia. Worm gears to 36" dia.

SPLINED SHAFTS—Lengths to 52". Diameters from 1" to 6".

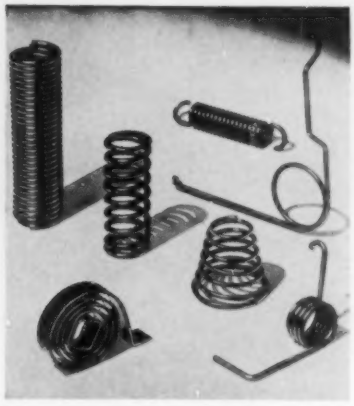
DIFFERENTIALS—10,000 to 300,000 inch pounds capacity.

Note: All of the sizes above are approximate.

Ask for interesting, illustrated bulletin.

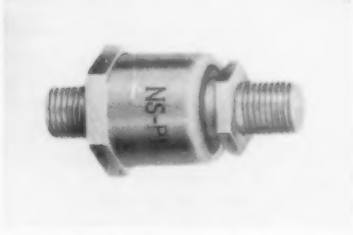
FAIRFIELD MANUFACTURING CO.

2305 South Concord Road • Lafayette, Indiana



bronze and beryllium copper are available. Springs in wire from 0.004 to 5 in. and in bars up to 1¾ in. round and square are produced. California Spring Co., 1746 Los Angeles St., Los Angeles, Calif.

For more information—Circle 45, inside back cover



Rectifier Operates at Up to 200 C

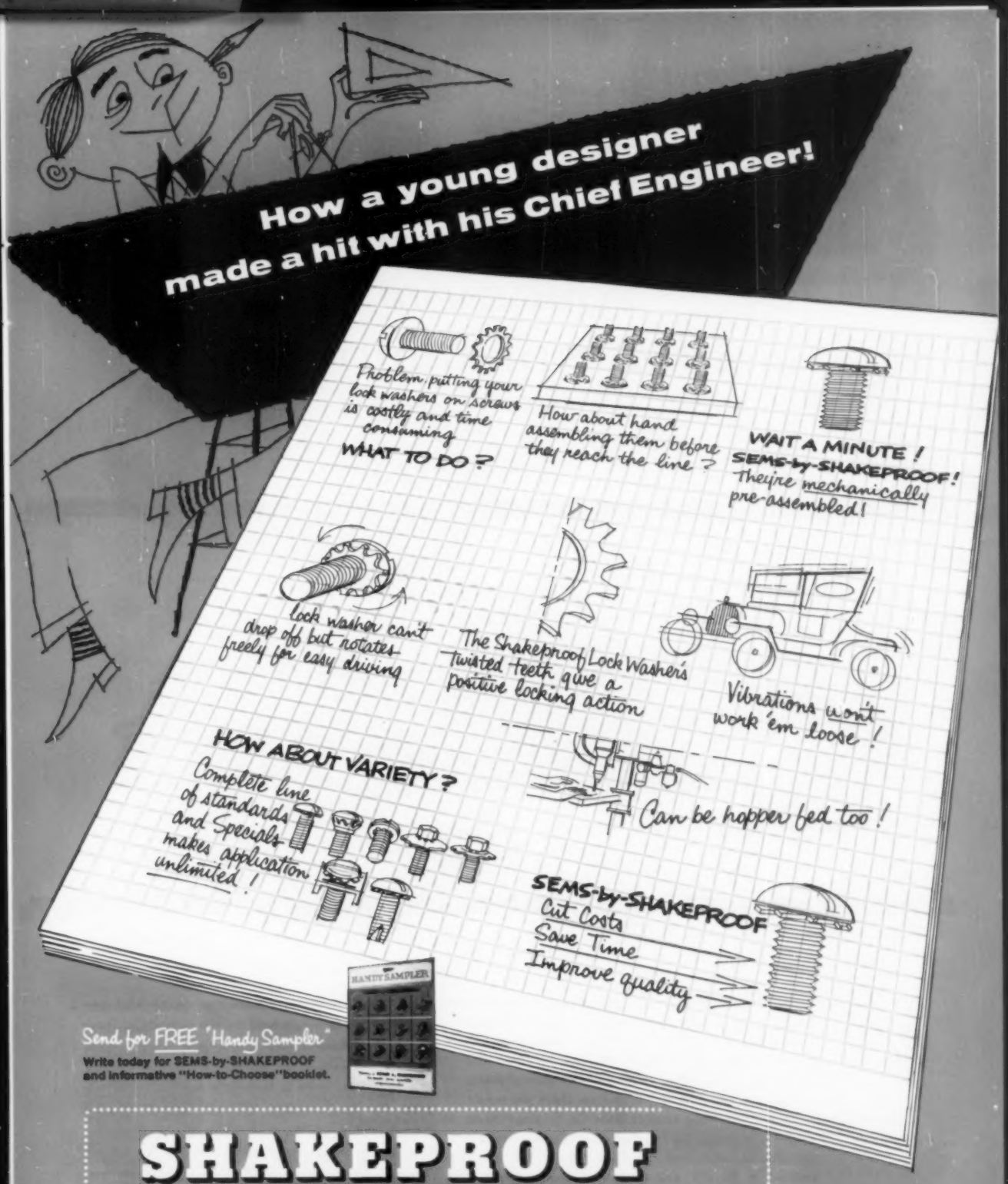
The rectifier is housed in a shock and vibrationproof case measuring approximately 1⅛ x 1¼ in. height. Maximum reverse working voltage is 60 v and minimum breakdown voltage is 70 v. Forward current density at 1 v drop is in excess of 600 amp per square inch of junction area. Hoffman Electronics Corp., 3761 S. Hill St., Los Angeles 7, Calif.

For more information—Circle 46, inside back cover

Power Supply With Variable Transformer

Variable output power supplies have built-in variable transformers which control input and output voltages. Control dial on the transformer is calibrated in percentages of line

(Continued on page 248)


How a young designer made a hit with his Chief Engineer!
Problem: putting your lock washers on screws is costly and time consuming
WHAT TO DO?
How about hand assembling them before they reach the line?
WAIT A MINUTE! SEMS-by-SHAKEPROOF! They're mechanically pre-assembled!
Lock washer can't drop off but rotates freely for easy driving
The Shakeproof Lock Washer's twisted teeth give a positive locking action
Vibrations won't work 'em loose!
Can be hopper fed too!
HOW ABOUT VARIETY?
Complete line of standards and Specials makes application unlimited!
SEMS-by-SHAKEPROOF
Cut Costs
Save Time
Improve quality
HANDY SAMPLER
Send for FREE "Handy Sampler"
Write today for SEMS-by-SHAKEPROOF and informative "How-to-Choose" booklet.

SHAKEPROOF

"Fastening Headquarters"®

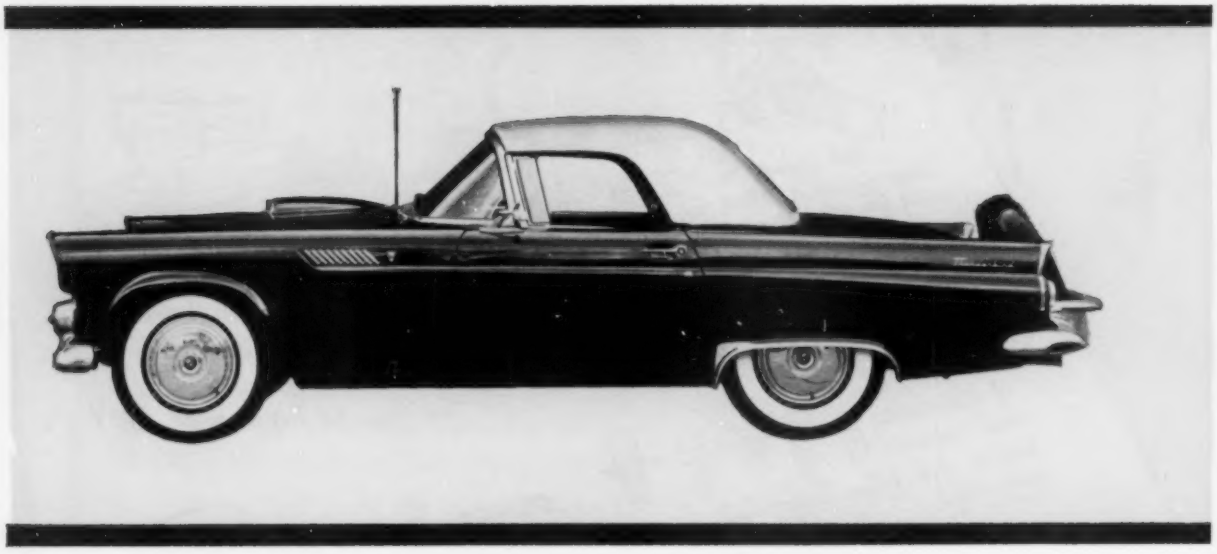
St. Charles Road, Elgin, Illinois • Offices in Principal Cities
In Canada: Canada Illinois Tools Limited, Toronto, Ontario

SHAKEPROOF
FASTEX

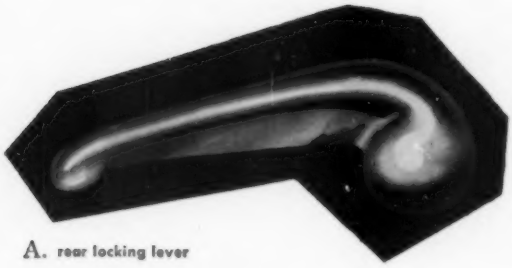
DIVISIONS OF ILLINOIS TOOL WORKS
World's Broadest Line of Mass-Assembly Fastenings

MUELLER BRASS CO. FORGINGS

give THUNDERBIRD tops a snug fit the year around



The Motor States Products Division of Detroit Harvester Co.—a major supplier of top assemblies for convertibles —has found Mueller Brass Co. forgings an ideal answer for securely fastening down the tops on the Ford Thunderbird. In a summer shower or in the snow of winter the top is always snug and draft-free. There are a pair of each of the three Mueller Brass Co. forgings shown here used in locking the Thunderbird top securely around the sides and rear deck. The locking lever (A) is incorporated in the top and operates a locking pin that fastens into the rear hold down clamp (B). A pair of side hold down clamps (C) are located just behind each door opening and clamp fasteners on the top hook into these forgings to rigidly hold the top in position. These forgings hold the necessary close tolerances and provide an excellent surface for buffing and chrome plating. In addition, the price is favorable and deliveries are good. For these reasons, as well as their inherent strength and durability, a switch to Mueller Brass Co. forgings can prove advantageous. Write today for our engineering manual (No. H-58565) . . . or better yet, call in one of our engineers to investigate possible forging applications in your products.



A. rear locking lever

B. rear hold down clamp

C. side hold down clamp

• WRITE TODAY FOR THE ENGINEERING MANUAL YOU NEED

Mueller Brass Co. Forgings
Engineering Manual H-58565 ☐

Tuf Stuf Aluminum Bronze Alloys
Engineering Manual H-58563 ☐

600 Series Bearing Alloys
Engineering Manual FM-3000 ☐

Copper Base Alloys in Rod Form
Engineering Manual FM-3010 ☐

METALS AND ALLOYS REVIEW

by FRANK M. LEVY, Director of Research

The other day one of our sales engineers stopped in to discuss gear applications and the subject got around to the amount of zinc permissable in gear and bearing alloys. Engineering books state that zinc is not desirable in bearing alloys. While this statement is true as regarding the commonly used copper-tin and copper-tin-lead alloys, it does not necessarily apply to other types of alloys. The 600 series bearing alloys, in which I am keenly interested, depend upon a high zinc content along with several other metal constituents to provide them with their fine bearing properties.

My explanation to our sales engineer was somewhat as follows: The question as to whether or not zinc is detrimental in a bearing alloy depends upon the remaining constituents in the alloy. A comparatively small amount of zinc is detrimental in a phosphor bronze alloy containing 80% copper, 10% tin and 10% lead. A zinc content of 4% is permissible in a bearing alloy containing 88% copper, 4% tin and 4% lead when used in an application not subject to heavy loads. In these alloys the tin combines with some of the copper to form a hard copper-tin constituent which is distributed through the soft copper matrix, or mat of copper. The higher the percentage of tin present, the greater the quantity of hard copper-tin constituent formed. Zinc also combines with copper increasing the hardness of the matrix. Therefore, when zinc is present along with a high tin content, the matrix becomes too hard and is "out of balance" resulting in poorer bearing qualities.

In the 600 series, copper, silicon, manganese, etc., are present with zinc. There is sufficient manganese present to combine with the silicon to form a purple manganese silicide which is embedded in the copper-zinc matrix. *Since the manganese-silicide constituent has a much higher micro hardness than the copper-tin constituent in phosphor bronze, the matrix of the 600 series alloys can have a higher hardness without impairing the bearing properties. In this instance, zinc is not detrimental but desirable because it produces an alloy with a high Brinell hardness which resists pounding and distortion.*

Like many engineers, we, too, were skeptical of the bearing properties of the first 600 alloy developed. A manufacturer of worm driven truck transmissions was having difficulty with the failure of chill cast high tin bronze gears in busses used in the hilly section of Los Angeles and Pittsburgh, and solved his problem by using gears made from 600 metal.

Since that time, we have had over a hundred successful applications on difficult bearing problems where cast bearing bronzes have failed. An interesting observation is that once a customer uses 600 alloys, he not only finds other applications, but continues to use it over a long period of years. Our original customers are still on our books.

In conclusion, we agree that zinc is detrimental to the bearing properties of the phosphor bronze type of alloys, but is of benefit to the 600 series alloys, *as it makes a harder matrix*, permitting the alloy to resist pounding action better than the softer phosphor bronze alloys.

I've just about run out of space for this time but we'll have another subject for discussion later. If you have any problems or questions about non-ferrous alloys, just write me here at Mueller Brass Co. and we'll see what we can do.

MUELLER BRASS CO.

PORT HURON 17, MICHIGAN

170

NEWARK offers Superior "Fabricating and Assembling" Experience

We at Newark have many years' experience in the production of quality wire cloth. But we haven't stopped there. One division of our company is fully equipped and staffed to fabricate *any* part you need with a wire cloth insert.

We have experienced engineers ready to assist yours in the design of the part to assure making the best and most economical use of the mesh insert. And, we have the facilities and skilled personnel to fabricate the parts to your strict specifications in small lots or in production quantities to meet your production schedules.

It will pay you to investigate how you can take advantage of our experience in wire cloth manufacture and parts assembly. We shall be glad to quote on your requirements. Let us have complete details on specifications.

NEWARK for ACCURACY

We can furnish wire cloth woven from all commercially used metals. Sizes range from 4 inches (space cloth) to 400 mesh.

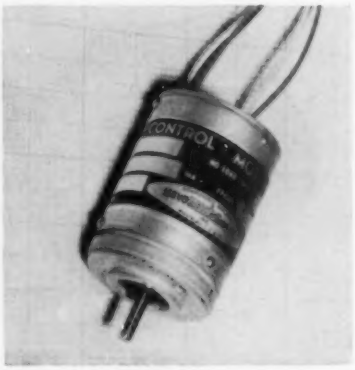
Send for Catalog E.

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

voltage, rather than in voltage, to simplify operation. Depending on the power supply involved, output ratings range up to 50.000 v. Input rating is 118 v, 60 cps. Condenser Products Co., Div. New Haven Clock and Watch Co., 140 Hamilton Street, New Haven, Conn.

For more information—
Circle 47, inside back cover



Miniaturized Servo Motor

Designed for operation in high ambient temperature applications, this 3-oz motor, which measures 1⅛ in. dia, is capable of withstanding continuous Class H operating temperatures. The motor is designed for a minimum life of 1000 hr of continuous operation at 150 C ambient temperature. Early tests indicate an expected life of 200 hr continuous operation at an ambient temperature of 180 C. Servomechanisms, Inc., 625 Main St., Westbury, N. Y.

For more information—
Circle 48, inside back cover

Tubular Selenium Rectifiers

Especially developed for high-voltage, low-current applications are five small, disk-type, tubular rectifiers. They are available in physical sizes which range through ⅛, 7/32, 9/32, ⅜ and ½ in. dia and can be obtained in assemblies of one to 260 cells, mounted without spacer washers, in a high quality phenolic tube. Each end is fully closed with a brass cap, which is firmly secured to the phenolic tube and provides contact ferrules for fuse clip-type mounting.

The cells are rated 1, 2½, 5, 10 and

(Continued on page 249)

SPRAYLAT
COVERLAC SC-224
Strippable Coating
for: METAL SURFACES

Aircraft Skins
Electrical Appliances
Chrome Accessories
Textured & Structural Glass
Plumbing Fixtures
Stainless Steel Restaurant & Dairy Equipment
Chrome Furniture

You can achieve greater economy . . . and greater protection . . . with COVERLAC SC-224. Unequalled in its strength, pliability and "stripping off" qualities, it means the end to costly rejections and refinishing.

Easily sprayed on, COVERLAC offers complete protection against abuse during such procedures as blanking, drilling, routing, form rolling, riveting, shipping and even storage up to one year! After installation this tough durable coating may be quickly "peeled off" revealing an original "Fresh-From - the - Factory" look. Included among its many uses are the protection of stainless steel, chrome and nickel platings, vitreous enamels, and glass.

Why wait any longer to find out more about COVERLAC's economical protection against physical damage? Mail the coupon below today. We'll be glad to send you a FREE bulletin fully describing COVERLAC.

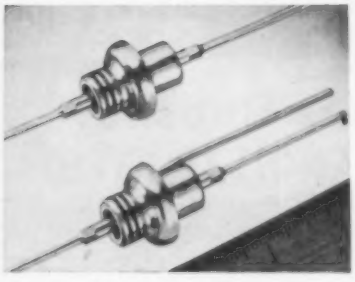
SPRAYLAT CORP.
One Park Ave., New York 16, N. Y.

"Specialists in the Development of Quality Strippable Protective Coatings since 1937"

SPRAYLAT CORP.
1 Park Ave., New York 1, N. Y.
Please send me bulletin M-2 describing COVERLAC.
name
position
address
firm name
city zone state

20 milliamp, d-c, per cell, in a half-wave circuit using a condenser input filter at maximum ambient temperature of 25 C. They have a reverse voltage rating of 26 v rms per cell. Union Switch & Signal Div., Westinghouse Airbrake Co., Pittsburgh 18, Pa.

For more information—
Circle 49, inside back cover



Germanium Fused Junction Transistors

These are medium power transistors, characterized by high gain and low noise figures. In addition, they exhibit a negligible alpha-crowding effect at high currents. The low alpha-crowding effect makes these new devices particularly applicable to high-current, medium-power amplifiers.

All three types have a maximum collector current of 100 milliamp, and a collector dissipation of 500 milliwatt. Dimensions, transistor body: 0.344 x 0.414 in. length. Hughes Aircraft Co., Culver City, Calif.

For more information—
Circle 50, inside back cover

All-Purpose Relays

The Model DO relay has a maximum contact combination of four-pole, double-throw. It is particularly adaptable to aircraft and mobile equip-

(Continued on page 250)

SPRAYLAT
SC-1071B
Strippable Coating
for: Painted, Lacquered and Enameled Surfaces

Aircraft
Instrument Panels
Radiation Laboratory
Automobiles
Welding Machines
Elevator Doors, etc.
Cabinets & Casework

Save valuable time and expense of refinishing and touching up. SPRAYLAT SC-1071B gives full protection during all factory operations, and outdoor storage. Easily sprayed on, this amazing plastic strippable film protects against scratches, oils, rust, grease, plaster, paints, alkalies, acids and fats.

So tough, the dried film maintains a tensile strength of over 3,000 pounds per square inch . . . and yet it's easy to remove by simply "peeling off." When the film is removed, the finished product will reveal its original lustre and color . . . completely free from scratches, smudges and defects!

SPRAYLAT SC-1071B is the perfect guarantee for top production and extra economy for you. It's your assurance that your product will be installed "Factory Fresh" . . . will look as you want it to look. We'll be glad to send you a bulletin fully describing SPRAYLAT.

SPRAYLAT CORP.
One Park Ave., New York 16, N. Y.

"Specialists in the Development of Quality Strippable Protective Coatings since 1937"

SPRAYLAT CORP.
1 Park Ave., New York 1, N. Y.
Please send me bulletin M-3 describing SPRAYLAT SC-1071B.
name
position
address
firm name
city zone state

NOW! IMPROVE CONTROL OF LIGHT AND COLOR, SIMPLIFY DESIGN WITH

BAUSCH & LOMB

MULTI-FILM

OPTICAL COATINGS

• SIMPLIFY PRODUCT DESIGN

With these compact optical elements you can provide desired degrees of reflectance and/or transmittance—selectively or non-selectively with respect to wavelength—and still keep design simple and practical. Multilayer coatings, so thin they are measured in fractions of a wavelength of light, are applied to glass substrates to control light and color to exact performance needs.

• REDUCE PRODUCT COST

Save by low-cost purchase from the most complete selection of standard designs, readily adaptable to specific needs. Production efficiency of America's major optical supplier will save you money on special orders.

Here are just a few typical applications

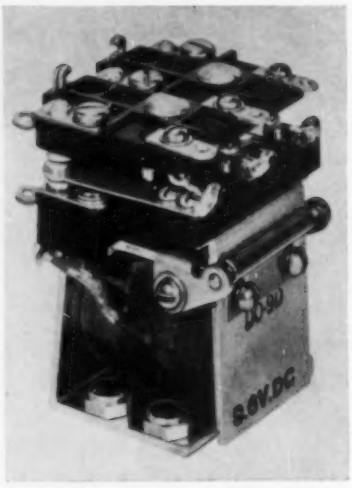
Full reflectance mirrors • All optical systems where losses must be kept to a minimum
Low pass, band pass, and high pass filters • Color separation • Additive color and subtractive color (Photographic) • Television • Printing filters • Photographic filters • Projection filters • Aerial cameras
Heat control filters • Projection systems—reduce heat without light loss
Conversion filters • Photography—compensate for emulsion characteristics under different light conditions
Neutral beam splitters • Combining or separating images • Simultaneous visual observation and photographic exposure • Interferometry

FREE DATA MANUAL

For your free copy of Multi-Film Manual D-279, and for complete information, write, wire or phone: Bausch & Lomb Optical Co., 66801 St. Paul St., Rochester 2, New York. (Phone: LOcust 3000).

BAUSCH & LOMB
SINCE 1853

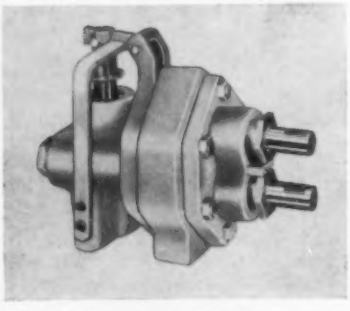
America's only complete optical source . . . from glass to finished product



ment applications where severe shock and vibration are encountered.

The contact and terminal insulation is of molded phenolic material. The design of the molded parts around the moving contact arms affords maximum protection against mechanical injury. Contact rating: 10 amp at 115 v, ac, or 32 v, dc, non-inductive load. The relay is available from stock in a wide range of operating voltages, for either ac or dc. Ohmite Mfg. Co., 3682 Howard St., Skokie, Ill.

For more information—
Circle 51, inside back cover



Spool-Type Three-Way Valve and Pump

This valve and pump assembly is designed for use with single-acting cylinders. The valve can be operated by cable or lever control, for raise, hold and lower position.

The unit is rated for 1000 psi duty and tested at 2000 psi overload and 3000 psi shock load. There is a built-in, adjustable, pressure relief valve.

(Continued on page 253)

DOW CORNING CORPORATION

Silicone News

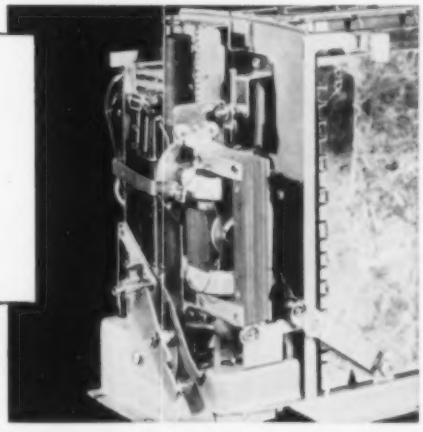
FOR DESIGN ENGINEERS No. 22

Pump Life Increased 30% With Silicone Lubricants

Friction between rubber and metal or plastic surfaces is easily overcome with Dow Corning 200 Fluid. Nonvolatile, nongumming and nontoxic, this silicone lubricant retains a relatively constant viscosity and remains serviceable at temperatures ranging from —40 to over 400 F. How these properties work to increase the life of plastic and rubber parts is demonstrated in this application reported by Vanton Pump and Equipment Corp. of Hillside, N. J.

Vanton manufactures the "Flex-i-liner," an ingeniously designed pump that handles corrosive or easily contaminated liquids without permitting them to come in contact with the metal pump mechanism. This is done with a flanged and flexible liner installed in a slot between the inlet and outlet openings. Rotation of a driving eccentric inside this liner produces the rolling action that forces

(continued pg. 2)



When a slice of bread is placed in a "Power Action" Toastmaster, the silicone insulated motor automatically lowers it and at the same time stretches a coiled spring with a 1½ pound pull. After the toasting cycle, this spring is released and the toast is gently elevated with motor serving as a damping device.

SILICONE INSULATED MOTOR MAKES "POWER ACTION" TOASTER POSSIBLE

Frequently, the sales appeal and efficient operation of a new product depends on locating the source of power close to the mechanism it drives. When this involves high ambient temperatures, as it did in the design of McGraw Electric's "Power Action" Toastmaster, silicone insulation becomes essential.

In this, the first motor-driven, completely automatic toaster, a small but powerful silicone insulated motor gets "toasted" with every slice of bread. Ambient temperatures are in the range of 400 F and operating time is one-third of a second during each toasting cycle. Accelerated life-testing by McGraw engineers indicates a life expectancy of 30 years under normal conditions of use. In the course of gaining Underwriters' approval these motors withstood a continuous locked rotor test for 8 hours without failure.

McGraw Electric also uses squares of silicone-glass laminate as an insulating material between the frame and the mica supports for the heating elements. Before this silicone-glass laminate was used, leakage current from the heating elements through the mica to the frame was 2.5 milliamperes. Now leakage current is practically zero. Fabricated by National Vulcanized Fiber Co., this laminate has excellent uniformity and high bond strength.

As added protection against moisture absorption and current leakage, all ceramic parts of the "Power Action" Toastmaster are treated with Dow Corning 200 Fluid.

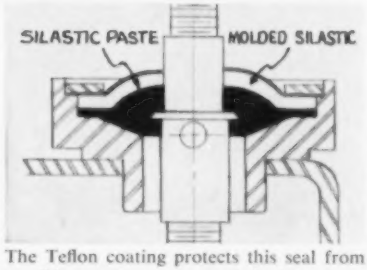
No. 218

EFFICIENT HERMETIC SEAL PRODUCED WITH SILASTIC

Low temperature flexibility of vulcanized Silastic*, plus the unique flowing and curing characteristics of this silicone rubber in paste form, have helped Electro-Snap Switch & Mfg. Co., Chicago, develop an unusually efficient, hermetically sealed limit switch.

The "wobble seal" diaphragm in this low temperature switch is comprised of an inner mass of Silastic paste, a layer of molded Silastic and a top coating of Teflon. On curing, the Silastic paste vulcanizes in place to form a resilient and moisture-proof seal between the outer case and the actuator.

Silastic stays resilient at —100 F. After long exposure to —100 F the Silastic seal on this snap action switch is still operable.



The Teflon coating protects this seal from possible exposure to aromatic hydrocarbons and reduces the adhesion of ice. Electro-Snap reports more than a million cycles of actual service without a leak in the seal.

Lead wires enter the switch through a hermetically sealed pin connector plug, the outer portion of which is filled with a grommet-type Silastic seal to plug the voids around the connector pin and eliminate the possibility of moisture condensation.

*T. M. REG U. S. PAT. OFF.

No. 219

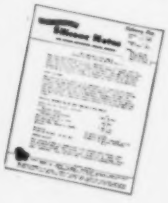
FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .



Documentary film "What's a Silicone?" available free of charge for showings to technical audiences in every industry. In full color and sound, this dramatic 16mm film allows you to see Dow Corning Silicones in action improving the performance of products ranging from nursing bottle nipples to diesel locomotives. For more information about this educational film and how to arrange a showing for interested persons in your plant, circle *No. 222*

Now available—The 1956 Reference Guide to Dow Corning Silicone Products. A concise, comprehensive, 12 page reference that is convenient-to-use. It's packed with data, properties, and information on how you can use silicones in designing new equipment, improving performance and reliability of original equipment, or reducing production and maintenance costs. *No. 223*

Silicone Additive Creates Hammer Finishes. Dow Corning F-4290, effective in the range of 0.1 to 1 part based on the total formulation, is easily incorporated with such vehicle resins as coconut or soya alkyd-melamines, epoxies, silicones, and acrylic or nitrocellulose lacquers. *No. 224*

Silastic 432 Base, a reinforced gum for compounding silicone rubbers, provides low shrink and low compression set characteristics without the use of toxic additives; is partly filled with silica to minimize compounding time. *No. 225*

"Silicone Glass Parts by Vacuum Laminating" a reprint from MATERIALS AND METHODS, gives detailed procedures for making short runs of oversize, complex, or experimental parts without the expense of production molds; is supplemented with several illustrative photos. *No. 226*

Specifications for Silicone Fluid—Electrical Grade is a new data sheet that briefly describes the various tests of dielectric and physical properties that electrical grade Dow Corning 200 Fluid must pass before shipment. *No. 227*

Silicone Paint Superior to Other Finishes for Trailer Bathtubs

With properties that overcome the limitations of both conventional organic finishes and vitreous enamels, silicone-based paints are helping designers engineer longer-lasting beauty and service into a broad range of products. One of the most recent examples is the finishing of housetrailer bathtubs by Sherer-Gillett Co. of Marshall, Mich.

The porcelain enamel formerly used on these cold-rolled steel tubs was expensive to apply, and necessitated an extra hand wiping operation to remove excess enamel from corners and edges. This coating added 25 pounds to each tub and often caused the metal to warp, resulting in high scrap losses. Porcelain finishing also meant high shipping costs plus the hazard of damage to tubs during handling.

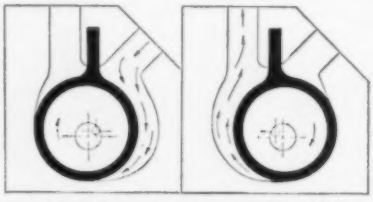
All of these problems have been eliminated by switching to a silicone-based paint. It is easily and efficiently spray-applied, and there is no longer any need for the costly hand wiping operation. This paint is cured by baking to give a high gloss finish that is flexible enough to withstand handling without cracking or chipping. Exhaustive lab tests and field experience have proved that it also has excellent resistance to alkali, acids, humidity and salt spray, and retains its original attractiveness after rugged service.

Sherer-Gillett's finishing process is simple and economical. Tubs are preheated for 30 minutes at 450 F to remove accumulated oil; then bonderized and sprayed with white Nubelon-S, a modified silicone-based finish formulated by Glidden. After a 30 minute bake at 425 F, the tubs are lightly sanded, wiped down and given a final spray coating and baking. *No. 220*

SILICONE LUBRICANTS *(continued)*

liquid through the pump. Capacities range from ⅛ to 20 gallons a minute.

"Flex-i-liners" are available in natural rubber, Buna N, Hycar, neoprene or Silastic®, Dow Corning's silicone rubber. In every case, however, the service life of the liner depends on keeping friction at a minimum between its inner surface and the eccentric rotor.



Originally Vanton lubricated these liners with various organic oils and greases depending on the type of rubber. In service, however, all organic lubricants soon lost their effectiveness and friction-increasing deposits of solidified grease built-up on the rotors. Contact with organic lubricants also caused the liners to deteriorate necessitating frequent liner replacement.

In 1950, Vanton engineers switched to Dow Corning 200 Fluid, 2000 centistokes, for lubricating all types of liners. The coefficient of friction between rotors and liners dropped from an estimated .60 to .01; build-up on the rotors was eliminated; and service life of the liners was increased by as much as 300%.

In addition to solving Vanton's lubricant inventory problem and giving the pumps longer service life, 200 Fluid reduced assembly time 15% by making it easier to slip liners into place.

Vanton also applies Dow Corning 200 Fluid to ball bearings to simplify assembly and to reduce corrosion. *No. 221*

®T. M. REG. U. S. PAT. OFF.

Dow Corning Corporation, Dept. 0601, Midland, Michigan

Please send me: 218 219 220 221 222 223 224 225 226 227

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE___ STATE_____

SILICONE NEWS is published for product design and development engineers by

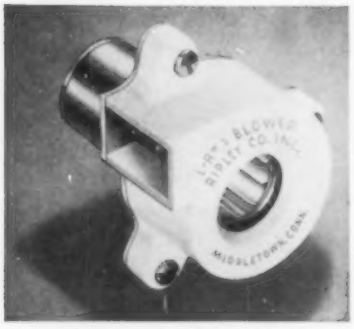
DOW CORNING CORPORATION
MIDLAND MICHIGAN

first in silicones
DOW CORNING SILICONES

ATLANTA CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D.C. (SILVER SPRING, MD.)
CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST. GOBAIN, PARIS

The valve-pump is available in 5 sizes, developing from 8 to 22 gpm at 1000 rpm-1000 psi. Wisconsin Hydraulics, Inc., 3165 N. 30 St., Milwaukee 16, Wis.

For more information—
Circle 52, inside back cover



Subminiature Blower

Using a 1 in. dia impeller, this unit will move 8 cfm at 1 in. static pressure when running at 20,000 rpm. Total weight of blower and motor unit is less than 2¾ oz. Available in both clock-wise and counter-clockwise rotation. Ripley Co., Inc., Middletown, Conn.

For more information—
Circle 53, inside back cover

Subminiature Connector

The connector is available with three, four and five contacts, and features one-piece molded inserts. Inserts are interchangeable in the plug or receptacle shell. Precision-machined

(Continued on page 254)

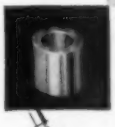
ANNOUNCING

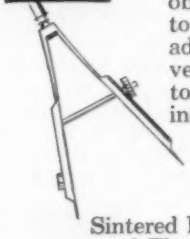
. . . SINTERED POWDERED METAL BEARINGS and PARTS

by **Bunting!**®

The newest facilities for the production of bearings and parts made of Sintered Powdered Metal are now offered to designer, engineer and machinery manufacturer by The Bunting Brass and Bronze Company.

Bunting resources, reputation and responsibility together with a complete new plant and modern equipment provide Sintered Powdered Metal products at a high point of quality and precision.





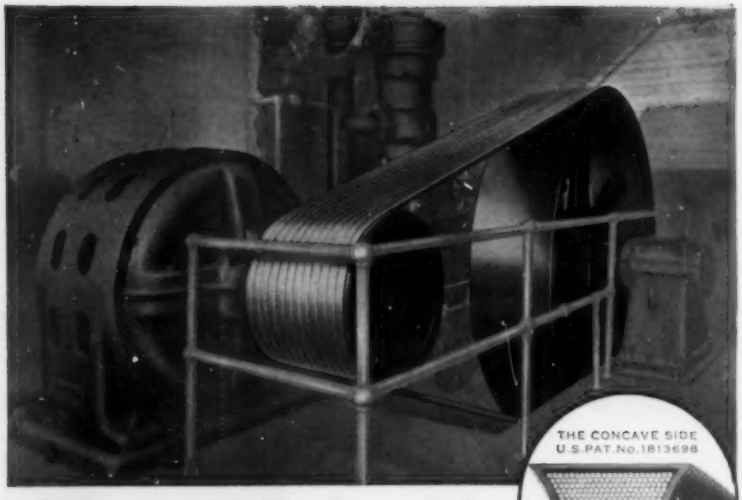
Bunting Engineering is available without cost or obligation to all who wish to use or explore the cost advantages that this versatile product brings to the mechanical industries.

Sintered Plain and Flange Bearings, Solid and Tubular Bars and Thrust Bearings are available from stock in a wide range of sizes. Quotations for special bearings or special parts will be sent promptly on receipt of prints.

Bunting®

BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS OF CAST BRONZE AND POWDERED METAL

The Bunting Brass and Bronze Company • Toledo 1, Ohio • Branches in Principal Cities



Why a V-Belt with CONCAVE SIDES wears longer

It is easy to demonstrate to yourself why the concave sides (Fig. 1) of the Gates belt greatly lengthen belt life.

Simply bend a Gates belt and feel the sides. Notice how these precisely engineered concave sides *fill out* on the bend and *become straight.* Thus a Gates belt grips the sheave groove evenly (Fig. 1-A) and wear is distributed uniformly across each side of the belt. That means longer belt life; lower costs.

Make the same test with a straight-sided belt (Fig. 2) and see what happens. The sides bulge out on the bend (Fig. 2-A) concentrating the wear at points shown by arrows.

To assure longer wear and keep belt costs down, specify the V-belt with concave sides—Gates Vulco Rope . . . readily available from nearby distributor stocks. The Gates Rubber Company, Denver, Colorado —*World's Largest Maker of V-Belts.*

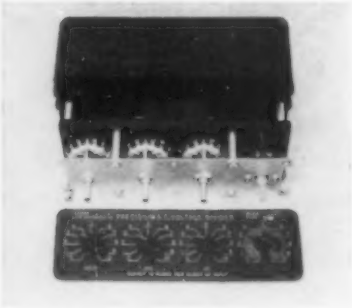
There are Gates Engineering Offices and Distributor Stocks in all industrial centers of the United States and Canada, and in 70 other countries throughout the world.

TPA 60

Gates VULCO ROPE Drives

brass pin contacts and spring temper phosphor bronze contacts are gold-plated for ease of soldering. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

For more information—
Circle 54, inside back cover



A-c Voltage Divider

This variable ratio transformer is suitable for panel mounting in equipment of all types. Front panel space requirement is 3 x 9 x 3½ in. deep.

Resolution is better than 0.0005 percent and accuracy better than 0.004 percent. Coast Coil Co., 5352 W. Washington Blvd., Los Angeles 16, Calif.

For more information—
Circle 55, inside back cover

Subminiature Relay

Dimensions of this relay are 1⅞ x 1⅜ in. dia and weight is 0.255 lb. Contact rating is 2 amp, non-inductive, at 26.5 v, dc, or 115 v, ac. Contact arrangement is four-pole, double-throw. U. S. Relay, 1744 Albion St., Los Angeles, Calif.

For more information—
Circle 56, inside back cover

Natural and Synthetic Rubber Sheet Packing

Stocks of rubber include red and black sheets in nylon and plate finishes for hot and cold water, general hydraulic conditions, steam and gas pressures; chute lining and skirt board rubber; floating stock for vibration dampeners, flexible joints, soft cushions, bumpers and soft sealing gaskets in hydraulic and general chemical services; commercial grade black and

(Continued on page 258)

Here's Why Clifford Specifies ALL-ANGL Barry Mounts to Protect Reliability thru Every Flight Attitude — of the F-100

Clifford miniaturized heat-control unit — only 3-1/8 inches high.

It's an important story of engineering for shock and vibration control

North American Aviation, builders of the F-100 Super Sabre, specify that the control box must be able to mount at any angle. MIL-E-5272A requires the mount to operate under vibration as high as 0.080″ double amplitude. Temperature requirements preclude the use of rubber mountings. And experience demands that the mounting system handle the load bias added by large connectors and cables — often a serious problem with miniaturized equipment.

Because they are specifically designed for jet and missile service, ALL-ANGL Barry Mounts meet all these requirements. So Clifford's choice of this mount assures the protection of their new miniaturized heat control under every operational condition.

The ALL-ANGL Barrymount® isolators used in the Clifford base are standard miniature size. These advanced-design mountings are also available in MIL-size 1 and (Feb. 1) MIL-size 2. Write for data sheets.

When your problem is protection through all flight attitudes, your answer is ALL-ANGL Barry Mounts. For recommendations, call your Barry Sales Representative.

BARRY B MOUNT

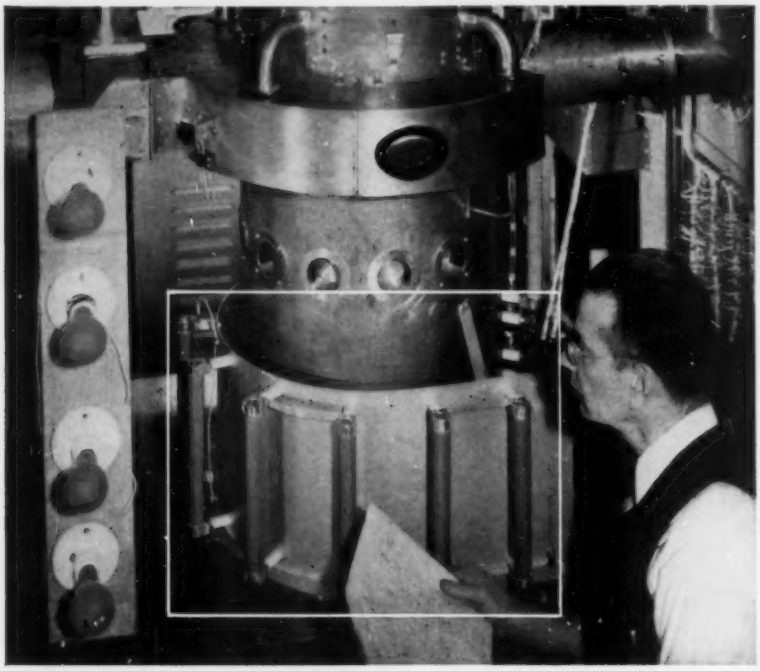
BARRY CONTROLS
INCORPORATED
SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

New engineering opportunities are open in Barry's expansion program, at all levels in all departments. Send resumé.

730 PLEASANT STREET, WATERTOWN 72, MASS.

★ Control Components Digest ★

News and notes on resistors, rheostats, relays, motor controls, dimmers and other control components



BIG MOON RADAR undergoing tests. Ward Leonard resistors—like those in foreground—help this gear stay on the air—or, rather, on space.

New moon radar to explore outer space

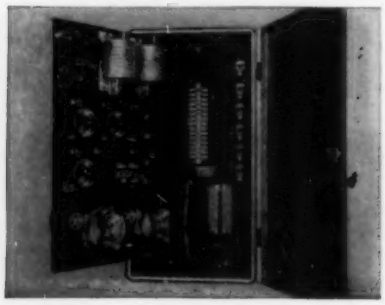
The U.S. Army Signal Corps hasn't got a transmitter in outer space—yet.

So, for their continuing studies of radio wave propagation in space and the upper atmosphere, they bounce radio waves from their new high-powered radar, Diana, off the moon and planets and study the return pulse.

Designed and built by Radio Engineering Laboratories of Long Island City, N. Y., the new radar transmitter puts out 50 kilowatts, continuous wave, and may be pulse modulated at various pulse widths and repetition rates. Receiver gain is 170-db at better than 3-db noise figure.

Throughout the equipment, high-stability Ward Leonard resistors, like the big Vitrohm resistors shown above, do duty as high-voltage bleeders, surge and current limiting resistors, and protective meter shunts in high-voltage circuits.

You'll find Ward Leonard Vitrohm resistors completely described in our 64-page Catalog No. 15, together with nomographs and charts to help select them. Write for your copy today.



Relays mastermind traffic lights

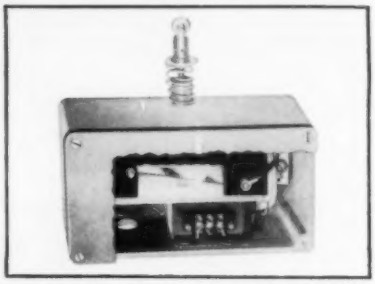
Sun, rain, sleet, snow, and continuous 24-hour-a-day duty is the lot of this master traffic light controller. Four dependable Ward Leonard relays select automatic timing cycles. Two more relays allow remote control of off-duty flashing amber signals and signal shut-down. Learn more about these rugged relays in Ward Leonard Bulletin No. 110.

Photo courtesy Crouse-Hinds Co.

SHE'S CHECKING CHART RECORD from X-ray spectrometer in Ward Leonard's test lab.

Plant X-ray speeds quality control and helps catch crooks

X-ray diffractometer and spectrometer tests insure high quality and uniformity of both raw materials and fabricated components at Ward Leonard. These instruments check crystal structure in ceramics, magnetic amplifier cores, contact metal, and resistance wire. In off hours, they help the Mount Vernon Police and Fire Department put the finger on crooks and arsonists.



AUTOMATION FOR MACHINE TOOLS is simplified by this precision control potentiometer.

Control for machine tools

Accurate electronic control component for cutting tools, winders and processing machine drives is provided by this compact, precision potentiometer.

A half-inch plunger movement drives the metal alloy contact across the special resistance element. Enclosure is compact; calibration is permanent. Standard resistance—10,000 ohms; up to 25,000 ohms on special order. Write for Bulletin 68. 63

WARD LEONARD ELECTRIC COMPANY
63 SOUTH ST., MOUNT VERNON, N. Y.

Result-Engineered Controls Since 1892

RESISTORS · RHEOSTATS · RELAYS · CONTROLS · DIMMERS

Use WELDED STEEL for Greater Strength with Less Weight!

Illustrated above is one of two Walking Shoes for a large wheel excavator employed in strip mining operations . . . it is one of many heavy parts and assemblies of parts fabricated and machined by Mahon for manufacturers of several types of mammoth earth moving machines. If you can use weldments to advantage in your product, you can turn to Mahon for complete service including design or redesign, fabrication, machining and assembling. Steel-Weld Fabricated parts and products shown at left are typical of thousands produced by Mahon for manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment. If you need weldments, or welded steel in any form, you will find a unique source in the Mahon organization . . . a source where design skill and advanced fabricating techniques are supplemented by craftsmanship which assures a smoother, finer appearing product embodying every advantage of Steel-Weld Fabrication. See Sweet's Product Design File for information, or write for Booklet showing Mahon's facilities to serve you.

THE R. C. MAHON COMPANY • Detroit 34, Michigan

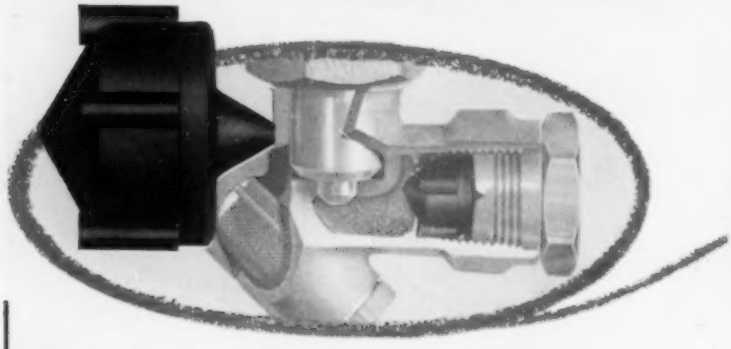
Sales-Engineering Offices in Detroit, New York and Chicago

Engineers and Fabricators of Steel in Any Form for Any Purpose

MAHON

THE SHAPE OF THINGS IN MOLDED RUBBER

MOLDED DIAPHRAGM
GIVES TOP PERFORMANCE IN WATER



APPLICATION:
The diaphragm shown here is the heart of a precision water flow control device for use in various appliances where automatic water flow control is necessary. It automatically maintains one set water flow regardless of inlet pressures or temperatures. This new unusual device is manufactured by a company famous for supplying brass and iron products for the water, gas and plumbing industries.

PROBLEM:
This diaphragm, less than 1" in diameter, must withstand pressures from 10 to 150 lbs. psi. and guaranty water delivery within 10% ± of the valve rate capacity. The diaphragm must also flex in temperatures ranging from 50°F. to 150°F. Mold it and make it work!

SOLUTION:
Acushnet engineers designed and used an injection mold to obtain the necessary precision. Strict production controls were instituted to maintain high quality parts. All neoprene stock prior to molding was checked for physical properties and weight. Samples were taken from every heat for flow tests approximating five days. For extra quality control, stocks that did not produce parts to the spec were scrapped. Acushnet now molds a complete line of precision neoprene diaphragms for this customer.

Acushnet offers complete under-one-roof facilities for the accurate compounding, engineering and precision molding of rubber, silicone and silicone resin parts. Apco technical representatives located in key industrial areas are ready to help you with your problem.

Send for Acushnet "Rubber Data Handbook."

What's Your Shape?

Acushnet

ACUSHNET PROCESS COMPANY
NEW BEDFORD, MASSACHUSETTS

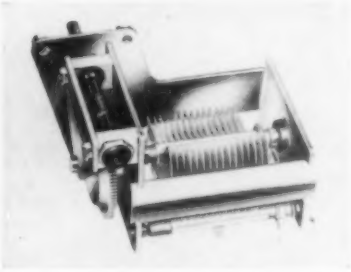
... *Precision Molded* **RUBBER, SILICONES - "APCOTITE" BONDING**

Address all communications to **768** Belleville Ave., New Bedford, Mass.

black neoprene for oil and solvent resistant seals and gaskets on hatches, doors, joints, pumps, tanks or pipelines; black diaphragm sheet for blankets, curtains, cut gaskets, reducing valves and regulators to resist swelling in petro-chemical, acid, alkali and comparable service.

This rubber sheet stock comes in standard 36 and 42 in. rolls in thicknesses from ⅛ in. Quality Rubber and Transmission Co., Dept PEN, 2203 W. Chicago Ave., Chicago 22, Ill.

For more information—
Circle 57, inside back cover



Worm-Drive Capacitor

This capacitor has a precision 100:1 worm-drive specifically designed for electronic equipment. The rotors and stators of the new unit are insulated with new high-strength pink or blue alumina ceramic rods, which are held in a manner so as to be under spring tension highly resistant to shock, yet extremely stable. Nickel-steel alloys

(Continued on page 262)

How forged weldless rings and flanges...
improve your product and cut your costs
Standard Steel Works Division
Burnham (Mifflin County), Pa.
BALDWIN-LIMA-HAMILTON

free! this informative booklet on...

"How forged weldless rings and flanges improve your product and cut your costs"

Standard Steel Works Division
BALDWIN-LIMA-HAMILTON

When you consider a change in your product, you expect that change to make money for you or to save money for you.

It's quite possible that Standard Steel Forged Weldless Rings and Flanges will do *both*.

They improve your product, thus making your sales task a little easier, and they cut your manufacturing costs. In many cases, first cost may be less than the component you now use, and always machining time is less.

In checking through this detailed booklet, you'll be able to determine in five minutes or less whether they're worth investigating further. Send the coupon now.

Dept. 8735, Standard Steel Works Division
Baldwin-Lima-Hamilton Corporation, Burnham, Pa.

Please send me Bulletin No. 10,000, "How Forged Weldless Rings and Flanges Improve Your Product and Cut Your Costs."

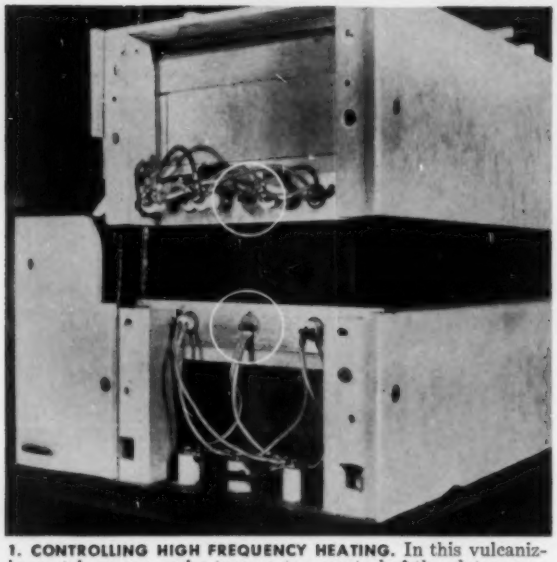
Name _____ Title _____

Company _____

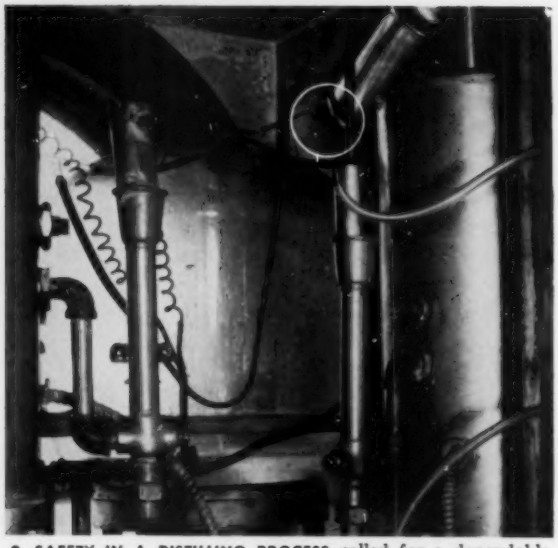
Address _____

City _____ Zone ____ State _____

How would you solve these tricky temperature control problems?

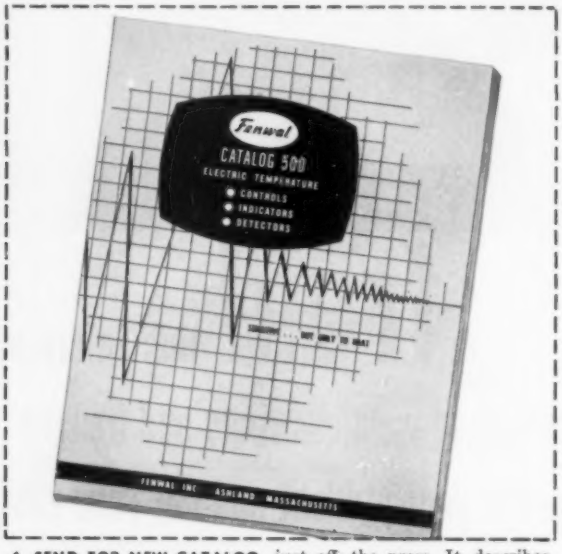


1. CONTROLLING HIGH FREQUENCY HEATING. In this vulcanizing patch press, precise temperature control of the platens was required to prevent loss of electronic heat generated within the processed material. Fenwal's solution was two THERMOSWITCH® units, set at 400F, mounted on the platens. Result: a production rate of 3,000 patches per hour, compared to ordinary hot press methods of 30 per hour.



2. SAFETY IN A DISTILLING PROCESS called for a dependable failure alarm. A Fenwal THERMOSWITCH unit in the condenser's safety vent solved the problem. Now, should the cold water supply fail, steam blowing through the condenser tubes will hit the THERMOSWITCH unit. This control, set at 120F, will then open, shutting off the electric heaters and sounding a continuous alarm.

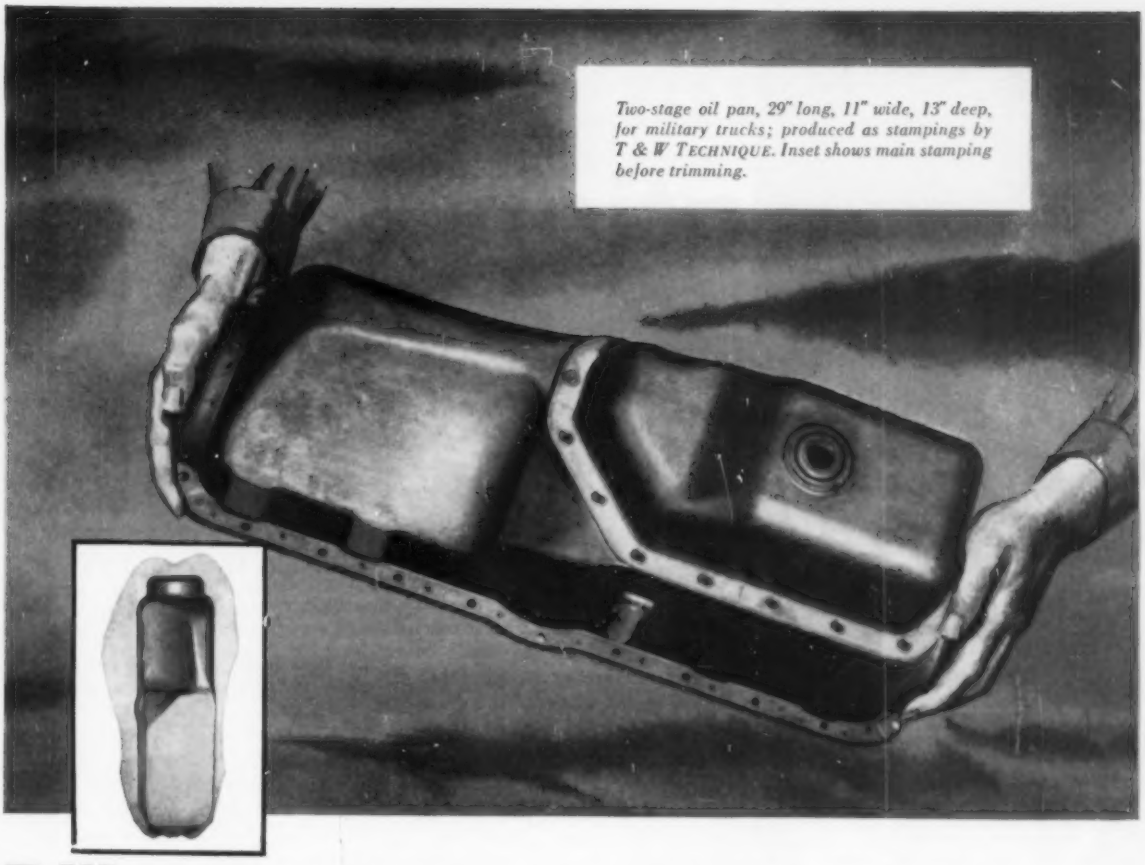
3. PROTECTING PRODUCTS. In this shoe lining smoother, the problem was twofold: to use the fewest possible thermostats; provide close temperature control in order to prevent burning of shoe leather. Fenwal's solution: a single adjustable THERMOSWITCH unit, mounted on one ironer and controlling two ironers. This halved the number of thermostats indicated, while providing precision temperature control.



4. SEND FOR NEW CATALOG, just off the press. It describes Fenwal's complete line of THERMOSWITCH units and new indicating controllers for industrial applications. Fenwal engineers are always glad to help on any of your temperature control problems. Write **Fenwal Incorporated, 21 Pleasant St., Ashland, Massachusetts.**

Fenwal **THERMOSWITCH®**

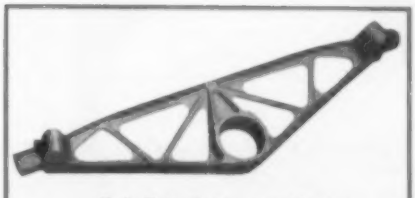
Controls Temperature — Precisely



Two-stage oil pan, 29" long, 11" wide, 13" deep, for military trucks; produced as stampings by T & W TECHNIQUE. Inset shows main stamping before trimming.

T&W TECHNIQUE can save production dollars for you

● If you buy stampings or forgings, then you want to know all about T & W Technique. Benefits from T & W Technique come to you in many ways — in effective design and engineering service, in extra skill which completes hard-to-produce parts without delay, in quality control, in delivery on schedule. But, always, forgings and stampings from T & W are likely to meet your needs so well that they cost you less at the point of assembly.



T & W Technique provides you with forgings like this fulcrum, as well as stampings, which meet your needs better, help you save production dollars.

STAMPINGS
T&W
FORGINGS

TRANSUE & WILLIAMS

Over 50 years of experience

Sales Offices:

NEW YORK • PHILADELPHIA • CHICAGO • INDIANAPOLIS
DETROIT • CLEVELAND • HOUSTON • LOS ANGELES

TO: Transue and Williams, Alliance, Ohio

Please let me know what "T & W Technique" can do for us. We are interested in

☐ Forgings ☐ Stampings

Name _____

Company _____

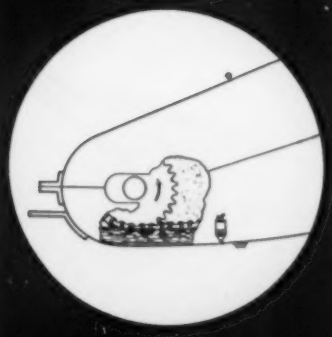
Street _____

City _____ Zone ____ State _____

1304

T & W DEEP DRAWN STAMPINGS AND FORGINGS USUALLY COST LESS AT THE POINT OF ASSEMBLY

Chain Lubrication



MANUAL, DRIP or IMMERSION?

Correct lubrication is essential to the long life of the chain drive. Mineral oils of varying viscosity are recommended. Methods of application are generally determined by the speed of the drive. Lubricants are applied by brush, immersion or by drip feed.

ACME'S Chain Engineers have the answers. They're yours for the asking. Whenever a chain problem arises, call in an ACME engineer . . . no cost to you! It's a part of ACME service.

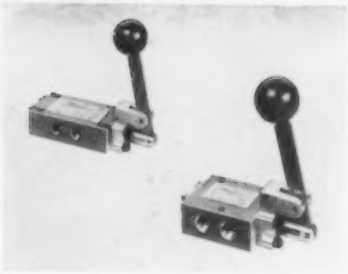
FREE ACME CHAIN TEXT!

Designers and engineers may write for a free copy of this 76 page chain text. It's loaded with chain data, specifications, illustrations and facts you should know about chain applications. Write ACME CHAIN CORP., Dept. 1B, Holyoke, Mass.

Acme Chain Corporation
HOLYOKE
MASSACHUSETTS

are used for the frame, rotor and stator, resulting in a temperature coefficient of practically zero. Johanson Mfg. Corp., Boonton, N. J.

For more information—
Circle 58, inside back cover



Air and Hydraulic Valves

Two, three and four-way lever-operated valves with rectangular body designs provide flat surfaces on all sides for easy and compact mounting. Ports are $\frac{1}{8}$ in 27 NPT. Valve body is $\frac{3}{4}$ x $1\frac{1}{2}$ x $3\frac{1}{16}$ in. long overall on three-way valves, $4\frac{3}{8}$ in. on four-way valves. Design incorporates a single sliding spool, with O-ring seals throughout. Body is of aluminum, with brass spool. Modernair Corp., 400 Preda St., San Leandro, Calif.

For more information—
Circle 59, inside back cover

Sun Battery Cells

These selenium cells are now in production in a wide range of sizes and power ratings, from 0.14 to 10.5 sq in. in photosensitive area and from 0.1 to 15 milliwatt power output in direct sunlight. Short circuit current up to 40 ma or open circuit voltages up to 0.5 v per cell can be generated in direct sunlight. These cells are available on straight bracket or on angle bracket mounts. International Rectifier Corp., El Segundo, Calif.

For more information—
Circle 60, inside back cover

Cool-Running A-c Relay

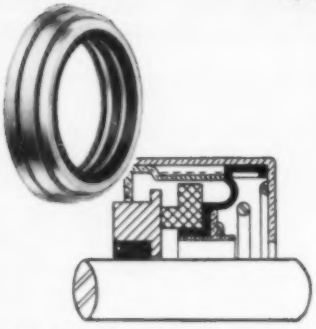
According to the manufacturer, this relay is a modified telephone-type design offering the advantages of telephone-type performance in an a-c relay. It is said to be cool operating, thus

(Continued on page 266)

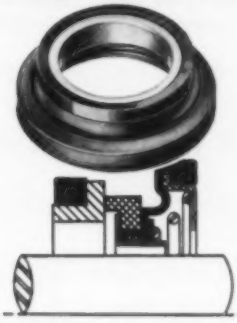
LARGEST STOCK SELECTION AVAILABLE ANYWHERE!

Modern, Mechanical, Face-Type Seals —
Standardized, To Save Time And Money

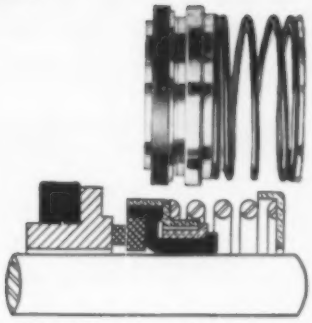
YOUR Sealing Problem Is Solved Here!



STYLE GU — A packaged sealing unit containing both rotating and stationary seal faces enclosed in metal housing. Important applications in **machine tools** and **power transmission equipment.** Stock sizes for shafts .250 through 4.000.

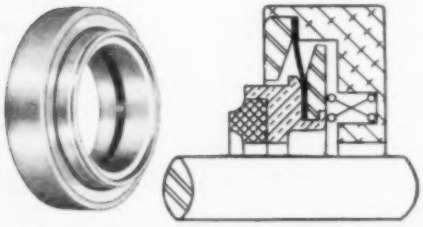


STYLE SGU—A factory-assembled unit-type seal for the small budget user. Widely used in **appliance** field. Stock sizes for shafts .250 through 1.000.

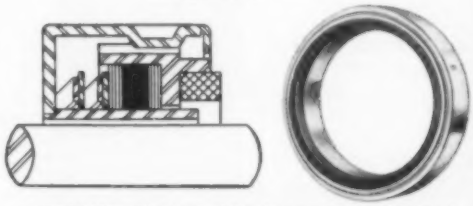


ROTO-FLEX — Rugged flexibility. Only 3 parts. Single or double units. Many applications in **pumps** and **compressors.** Stock sizes for shafts .250 through 4.000.

STYLE RFO—A specially designed Roto-flex seal, for installation outside the stuffing box. Stock sizes for shafts .250 through 4.000.



STYLE DPC — A high-speed, carbon-faced seal, for use where lubrication is poor or where shaft RPM and resulting friction are high. Ideal in many **machine tool** applications. Stock sizes for shafts .250 through 4.000.



STYLE HH—Absolute minimal space (both radial and axial) under extreme conditions of temperature, pressure and seal face surface speed. Features pressure balance when fluid pressure is applied internally or externally. Of particular importance to the **aircraft** industry. Stock sizes for shafts .250 through 4.000.

These are only a few of the countless sealing problems now being solved by

GITS SHAFT SEALS

Write for detailed data on any of these standardized stock Gits Shaft Seals.

GITS BROS. MFG. CO.
1838-B S. KILBOURN AVE., CHICAGO 23, ILL.

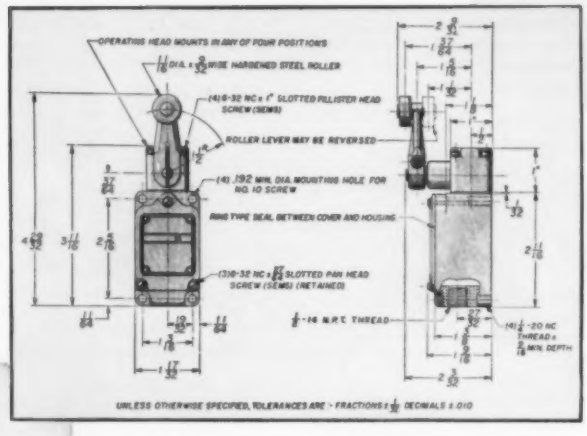
Specialists In Lubricating Devices And Shaft Seals For Almost Half A Century

MICRO SWITCH Precision Switches
A PRINCIPLE OF GOOD DESIGN

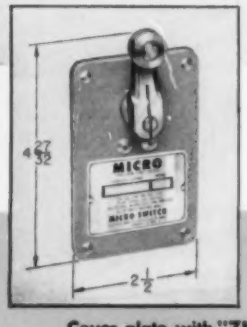
Introducing a New Series

New "LS" Series meets need for compact, precise, long-life, 2-circuit switches

Precision two-circuit switching unit is enclosed in a rugged aluminum housing.


OPERATING HEAD MOUNTS IN ANY OF FOUR POSITIONS
ROLLER LEVER MAY BE REVERSED
RING TYPE SEAL BETWEEN COVER AND HOUSING
UNLESS OTHERWISE SPECIFIED, TOLERANCES ARE ± FRACTIONS ± DECIMALS ± .010

Dimensional drawing shows compact size of the "1LS1" switch to permit small space mounting.



Cover plate with "7LS1" switch for mounting into recess in machine.

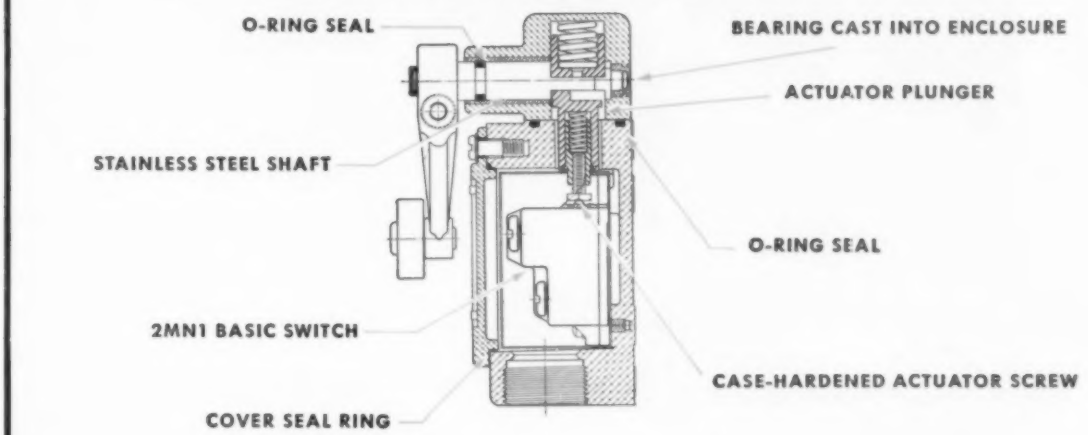
The new MICRO SWITCH "**1LS1**" Switch is a small two-circuit limit switch. Its sealed construction, reliability, long life and features of adjustability suit it to all types of industrial applications.

Also available is the MICRO SWITCH "**7LS1**" Switch. This is a flush-mounted design which may be recessed into a cavity in the machine. Operating characteristics of both switches are identical.

Contact arrangement of the basic switching unit is two-circuit, double-break. The electrical rating is: 10 amperes, 120, 240 or 480 volts a-c; ½ H.P., 115 volts a-c; 1 H.P., 230 volts a-c. Pilot duty rating is: 600 volts a-c, max.; .2 amperes, 115 volts d-c; .1 ampere, 230 volts d-c; .04 amperes, 550 volts d-c.

# of Precision Limit Switches

SEALS PROVIDE MAXIMUM PROTECTION



Sealing is provided by use of O-ring seals on the actuator shaft between the actuator head and the housing. A synthetic rubber ring seal is also provided for the cover. These seals provide maximum protection against entrance of dust, oil and other liquids. The switch meets NEMA specifications for an oil-tight pilot device.

ADJUSTABLE HEAD ASSEMBLY

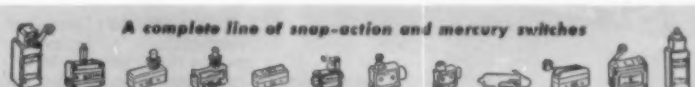
The "1LS1" switch can be easily mounted in almost any location. The actuator head may be removed in the field and rotated to any of four positions. Actuation of the switch is possible from any of the four quadrants to meet the requirements of the specific application.

FIELD ADJUSTABLE ACTUATOR

The roller arm actuator is field adjustable through 360 degrees, positively locking in any position. Actuators are assembled to operate in either direction. They can also be converted to operate in one direction only, clockwise or counterclockwise.

MICRO SWITCH field engineering is available to bring you more complete information on these new "LS" switches and help you select the exact switch to meet your switch requirements. Call the nearest MICRO SWITCH branch. Save time and money.

A complete line of snap-action and mercury switches



MICRO SWITCH provides a complete line of extremely reliable, small-size, high-capacity, snap-action precision switches and mercury switches. Available in a wide variety of sizes, shapes, weights, actuators and electrical characteristics. For all types of electrical controls.

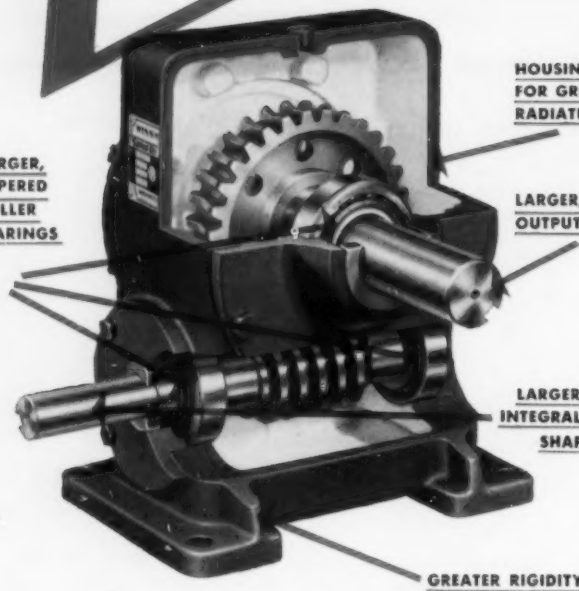
MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

H HONEYWELL

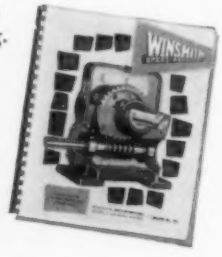
7 CHECK POINTS of Speed Reducer Design


HOUSING DESIGNED FOR GREATER HEAT RADIATING CAPACITY
LARGER, TAPERED ROLLER BEARINGS
LARGER, STRONGER OUTPUT SHAFTS
LARGER STRONGER, INTEGRAL WORM SHAFTS
GREATER RIGIDITY

...on the New "C" WINSMITH SERIES

THESE 5 IMPROVED FEATURES of Winsmith's new "C" Series reducers mean greater performance, greater stamina, greater dependability...*greater value for your horsepower dollar.*

In all, 108 models comprised of single and double reduction units are available in the "C" Series...a unit to answer every speed reducer need. Compare our *increased* rated horsepower and torque output with reducers of competitive makes. For complete data on the "C" Series, write for catalog.



WINSMITH SPEED REDUCERS

NEW CATALOG! Describes the complete "C" Series plus other units in the Winsmith line. Contains drawings, dimensions, weights and ratings for each model described. Write today for Catalog No. 155—on company letterhead, please.

WINSMITH, INC. 111 Eaton St., Springville, (Erie County), N.Y.

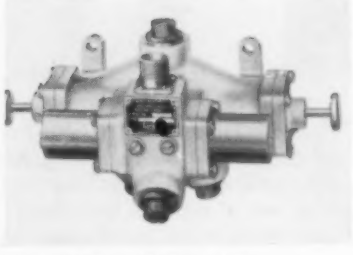
making it particularly suitable for use where hermetic sealing or dust covers are required. Typical heat rise in open air is 18 C. Coils can be supplied for all standard voltages up to 220 v, ac. Contact combinations, six pole, double-throw, are available up to 5 amp at average 7.5 va; four-pole, double-throw up to 5 amp at average 3 va; double-pole, double-throw up to 10 amp at average 7.5 va. Vibration, 10G at 5 to 55 cps depending on contact combinations. Size $1\frac{1}{2}$ x $1\frac{13}{16}$ x $2\frac{1}{4}$ in., depending on contact combinations. Available open, with dust covers, or hermetically sealed. Comar Electric Co., 3349 Addison St., Chicago 18, Ill.

For more information—Circle 61, inside back cover

Back-Ups for O-Rings

Back-up rings, solid, and solid with 22 or 30 deg cut, as well as the spiral, are now available. These back-ups protect the O-ring seal from extrusion or loss of efficiency and extend O-ring life. Chemically inert, the new packings have very low friction and are unaffected by oils, acids, bases or solvents. Operating temperatures range from —100 F to 500 F. Shamban Eng. Co., 11617 W. Jefferson Blvd., Culver City, Calif.

For more information—Circle 62, inside back cover

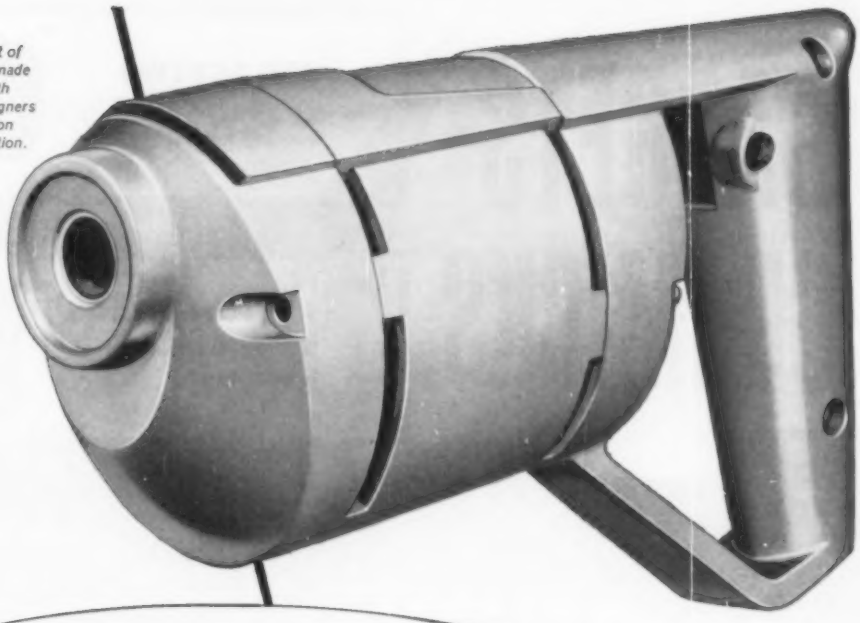


Four-Way Solenoid Selector Valves

Pilot-operated valves for 3000 psi hydraulic service are said to provide low current draw, low leakage and positive actuation. The valves are provided with AND-10050-4, —6, —8 ports for $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$ in. tube sizes. These valves are available with the

(Continued on page 271)

Illustrating complete set of Electric Drill Castings made in close cooperation with the Engineers and Designers at Signal Electric Division of King-Seeley Corporation.



Stand-by Designers

with MADISON-KIPP zinc and aluminum die castings

MANY modern product design programs include the use of special or stand-by designers to develop eye appeal or other sales advantages.

When die castings are involved, the skilled and seasoned Madison-Kipp mechanics can often offer valuable service in the pre-planning stage of product designing.

Our customers of long standing usually send us their rough layouts for review because this pre-planning has proved to be important in advancing time schedules and in establishing economies of manufacture.

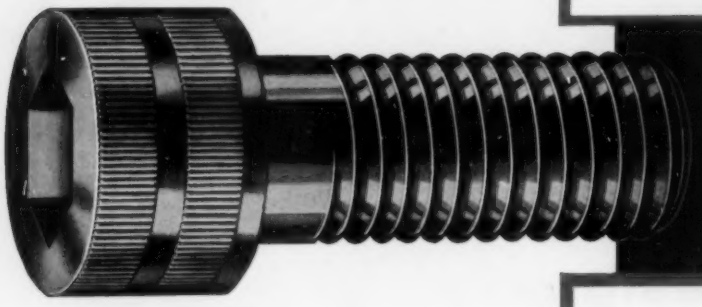
Please clip this ad as a reminder to contact us when you have die casting requirements.

kipp

MADISON-KIPP CORPORATION
206 WAUBESA STREET • MADISON 10, WIS., U. S. A.

• Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High Speed Air Tools

NO GADGETS-
NO GIMMICKS



SET SCREWS
For safety and high holding power.

BUTTON HEADS
Where countersinking is impractical.

CAP SCREWS
For high strength and compact design.

FLAT HEADS
For a smooth, unobstructed surface.

PIPE PLUGS
Precision threads for the tightest fit.

STRIPPER BOLTS
For concentric head, shoulder and thread.

DOWEL PINS
Special finish is corrosion-resistant, facilitates driving.

Holo-Krome Concentrates On Making Tough, Precision Socket Screws!

We offer the strongest, simplest, most accurate socket screws we can make!

For greatest strength and accuracy, we *completely* cold-forge the finest alloy steel. For maximum locking action, we thread to a Class 3 Fit.

When a socket screw is so carefully made . . . *it doesn't need any fancy "gadgets"!*

For the finest in socket screws . . . for SAME-DAY SERVICE ON STANDARD PRODUCTS . . . for cost-cutting packaging—the name to remember is HOLO-KROME!

Available from authorized Holo-Krome Distributors

HOLO-KROME

THE HOLO-KROME SCREW CORP. HARTFORD 10, CONN.

well-developed "muscles" for guided missiles

fuel pumps for special propellants

Special pumps have been developed to handle at either high or low pressure such difficult chemicals as propyl nitrate, nitric acid, ethylene oxide and others still classified; also liquid sodium.

high-speed, high-temperature hydraulic pumps

Newly developed Pesco pumps operate at speeds to 12,000 rpm, temperatures to 400°F. Designed for reliability, extended storage and vital savings in space and weight.

blowers for cooling electronic equipment

Miniaturized axial flow blowers with integral motors provide efficient cooling of "hot spots" in electronic equipment under both ground testing and flight conditions.

Now from Pesco come vital components for your missile development program. In working with leading firms holding missile contracts, Pesco has developed the "muscles" to pump propellants and operate controls.

These Pesco products conform to missile criteria: minimum size and weight, instantaneous action after long storage, unfailing dependability despite rigorous operating conditions.

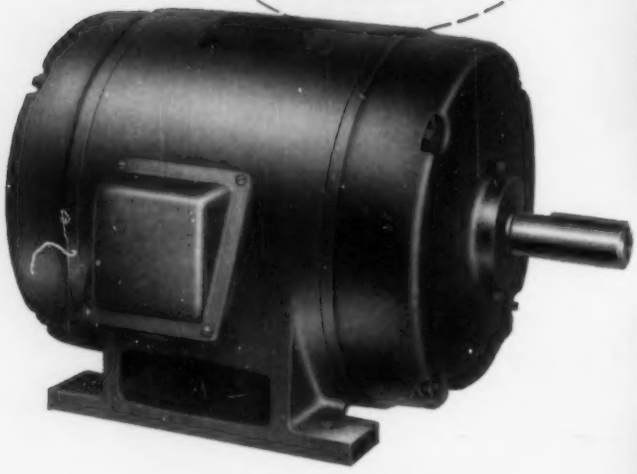
Take advantage of this unique experience by calling in Pesco on your missile program. Get complete information from: PESCO, 24700 North Miles Road, Bedford, Ohio.

engineering Pesco production

PESCO PRODUCTS DIVISION
BORG-WARNER CORPORATION
24700 NORTH MILES ROAD • BEDFORD, OHIO

Producing the Best in Hydraulic Pumps, Fuel Pumps, Electric Motors and Axial Flow Blowers

Wagner®
ELECTRIC MOTORS
...the choice of leaders in industry

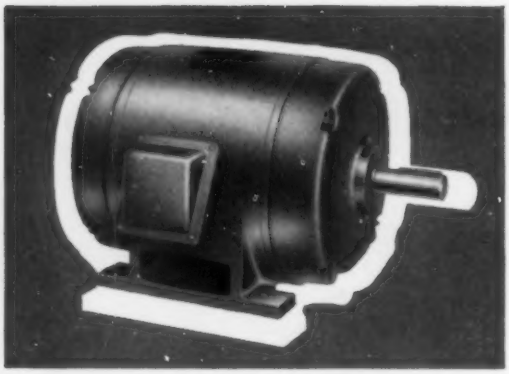


You get better performance with these Wagner DP Motors

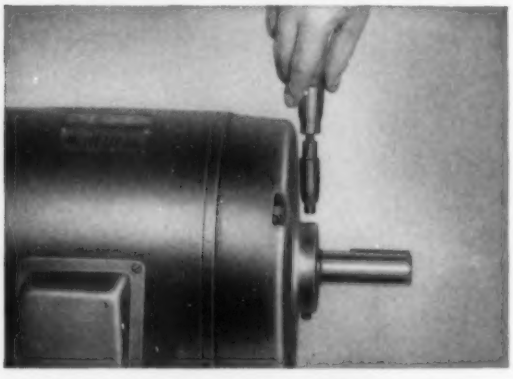
Wagner DP motors are *doubly protected* by (1) rugged, corrosion-resistant cast iron frames, smoothly rounded so that no moisture can collect on them. Motor feet are cast as an integral part of the frame for maximum strength and rigidity. (2) Enclosures on the DP motor are completely drip-proof—virtually splashproof. Air intakes are located at the bottom of the endplates and air outlets are located at the base of the frame—one on each side.

Although engineered to meet the re-rated NEMA specifications which call for more power in smaller frames, the same high quality and long life performance that have made Wagner Motors "the choice of leaders in industry" for many years has of course been retained.

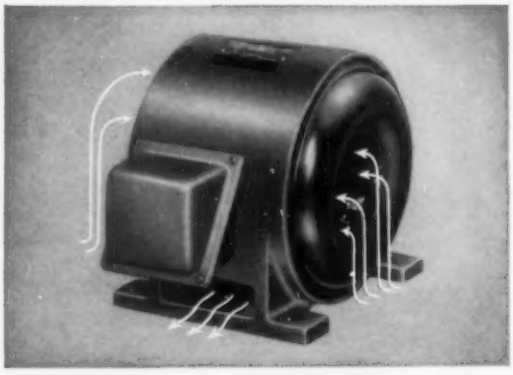
Full information and principal dimensions are given in Bulletin MU-202. Write for your copy today.



MORE POWER IN SMALLER FRAMES The Wagner DP Motor packs more power in a smaller frame and this smaller size means ease of handling and stocking ... less space required for installation.



CAN BE RE-GREASED FOR LONGER LIFE This motor will operate for years without regreasing ... bearings are completely enclosed ... however, provisions have been made for adding lubricant and for the removal of old grease in cases where re-greasing is necessary.



COOL RUNNING Specially designed baffles direct cooling air from the blowers through the motor and provide protection for the stator windings. Blowers are an integral part of rotor ... and move large volumes of air without noise or vibration.

Wagner Electric Corporation
6406 Plymouth Ave., St. Louis 14, Mo., U. S. A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

M56-4

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS-AIR AND HYDRAULIC

following variations: with or without manual override; three-position spring centered; two-position spring offset, three-position detent; with thermal relief; and with special spool and sleeve combinations to meet individual porting requirements.

The standard ambient temperature range is from −65 F to 160 F. These continuous duty valves are provided with single coil solenoids operating in the range of 18 to 30 v, dc. Aircraft Products Co., 300 Church Road, Bridgeport, Pa.

For more information—
Circle 63, inside back cover

Explosionproof, Internally Geared Motor

An aircraft electric motor suitable for pump or compressor drives, designed for continuous duty, operates on three-phase, 400 cps, 200 v, ac. It delivers 1.5 hp at 1500 rpm.

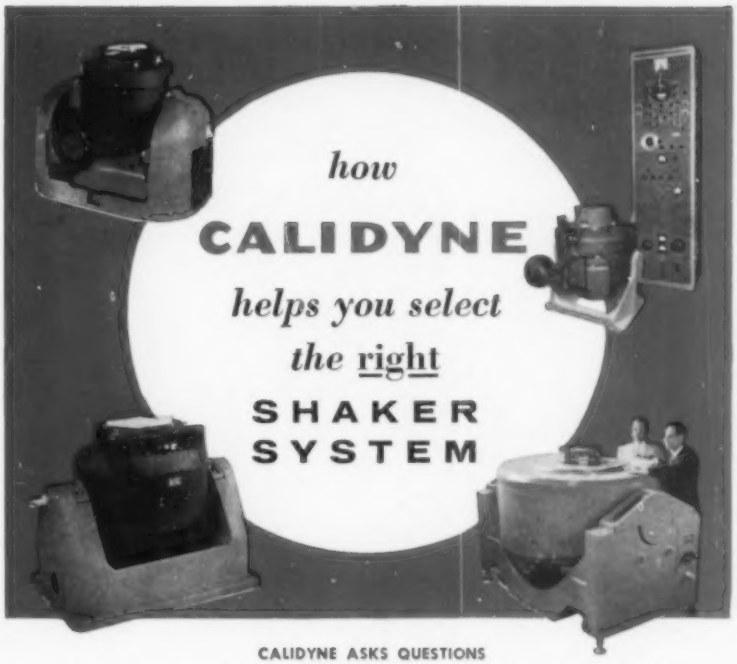
The motor weighs 17 lb. Rigid pyramidal design of base supports the motor and application very effectively with equal weight distribution on both sides. A sparkproof fan blows air over ribs to cool the motor. U. S. Electrical Motors Inc., Box 2058, Terminal Annex, Los Angeles 54, Calif.

For more information—
Circle 64, inside back cover

Carbon Film Resistor

A glass-sealed carbon film resistor has stability rated better than ± 0.03 per cent per year at 0.25 w and derating to zero power at 140 C. Using 0.5 w rating, derating to zero at 160 C, stability is better than ± 0.1 per

(Continued on page 275)



CALIDYNE ASKS QUESTIONS

When you inquire about Calidyne Shaker Systems, you're asked "What *type* of vibration testing is required — conventional environmental testing? Fatigue testing? Structural response determination? Mechanical noise reduction?" Further, "What are your present, and anticipated, requirements for force, frequency, and stroke?" In this way, Calidyne can recommend the equipment which will provide *maximum* usefulness for your investment, with as much flexibility as possible for future needs.

CALIDYNE DELIVERS

To meet your requirements, Calidyne offers complete Shaker Systems ranging in force output from 25 to 12,500 pounds. Systems consist of one or more electrodynamic Shakers, a rotary or electronic power supply, a control console and various optional accessories for monitoring, measuring or automatically cycling tests. Calidyne Shakers feature greater useful force output through lighter armatures, true linear armature motion, rugged construction. Certain Calidyne power supply units, also, will operate Shakers of widely different force outputs. Any accessory may be added to a basic system at any time, without costly revamping or modification.

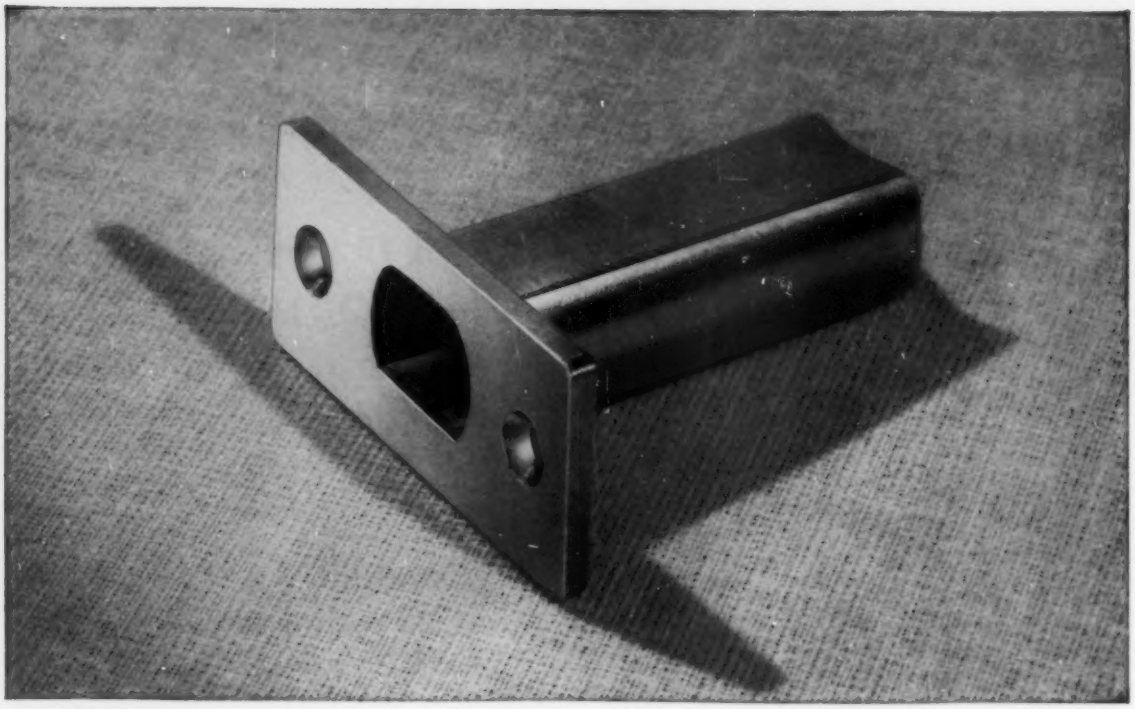
CALL CALIDYNE

For competent help in solving your vibration testing problems, or technical data on any Calidyne Shaker System, call Calidyne now.

THE CALIDYNE COMPANY
120 CROSS STREET, WINCHESTER, MASSACHUSETTS

SALES REPRESENTATIVES:

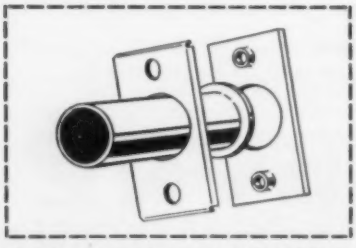
WALTHAM, MASS. Robert A. Waters, Inc. Waltham 5-6900
NEW HAVEN, CONN. Robert A. Waters, Inc. Fulton 7-6760
NEW YORK CITY AREA G. C. Engel & Associates Rector 2-0091
RIDGEWOOD, NEW JERSEY G. C. Engel & Associates Gilbert 4-0878
PHILADELPHIA, PA. G. C. Engel Chestnut Hill 8-0892
NORTHERN NEW YORK Technical Instruments, Inc. Waltham, Mass. Waltham 5-8445
CLEVELAND, OHIO M. P. Odell Co. Prospect 1-6171
DAYTON, OHIO M. P. Odell Co. Oregon 4441
DETROIT, MICHIGAN M. P. Odell Co. Superior 8-5114
WASHINGTON, D. C. F. R. Jodon, Inc. Hobart 2-4300
SOUTHEAST W. A. Brown & Assoc. Alexandria, Va. Overlook 3-6100
CHICAGO, ILLINOIS Hugh Marsland & Co. Ambassador 2-1555
INDIANAPOLIS, INDIANA Hugh Marsland & Co. Glendale 3803
MINNEAPOLIS, MINN. Hugh Marsland & Co. Colfax 7949
DALLAS, TEXAS John A. Green Co. Fleetwood 7-7385
HOLLYWOOD, CALIFORNIA G. B. Miller Co. Hollywood 2-1195
SAN FRANCISCO, CALIF. G. B. Miller Co. Lytell 3-3438
ALBUQUERQUE, NEW MEXICO G. B. Miller Co. Albuquerque 5-8606
SEATTLE, WASH. G. B. Miller Co. Lander 3320
CANADA Measurement Engineering Ltd. Arnprior, Ont., Phone 400 Toronto, Ont., Mayfair 8860
EXPORT Rocke International Corp. 13 East 40th St., N. Y. 16, N. Y. Murray Hill 9-0200



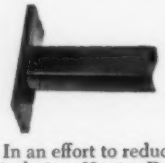
HOW TO MAKE 1 PART DO THE WORK OF 3

A typical example of product simplification with Hunter Douglas Aluminum Impact Extrusions.*

The barrels in most present day door locks are composed of several parts, each of which requires its own tooling, individual press run and a final assembly operation. The part illustrated is typical and construction is fairly standard throughout the hardware industry. It consists of a deep drawn barrel with a flange sandwiched between two mating and piloted plates. Crimping the edges on one of these unitizes the assembly.



Conventional manufacture of this latch bolt includes individual formation of these three pieces plus final assembly and a crimping operation.



Notice the square shoulder formed between barrel and flange. No fillet is required—strength is increased by flow of metal around juncture; fibers remain unbroken.

In an effort to reduce costs and simplify this design, Hunter Douglas recently completed tooling and supplied test parts on an impact extruded component serving the same function.

Even though the part was made from 2S aluminum, the cold working of the metal during the impact extruding process increased strength materially. The resulting part equalled strength requirements of the original design. In addition, the flange was integrally formed with the barrel, without need for joints, seams or fasteners. Impact extruding also insured both zero draft walls of tube and close dimensional tolerances.

The required barrel was unusual—a cylindrical shape with flattened sides. Again, impact extruding proved a most logical means of manufacture...desired part geometry being a direct result of die design and requiring no subsequent forming operations. Actual unit cost of the impact extrusions proved economical—without counting the savings made in tooling.

Typical variations of Hunter Douglas Cold Forgings which serve many industries.

If you are planning design changes or require a hollow component—with or without a closed end—in which zero draft, close tolerances, and high strength factors are desirable, a Hunter Douglas Aluminum Impact Extrusion or Cold Forging might supply the answer. A blueprint, sketch or sample part will bring a quick analysis from our engineering department.

**Hunter Douglas distinguishes parts as Impact Extrusions when formed from soft (2S) aluminum. Parts made from high strength aluminum alloys are designated Cold Forgings.*

DESIGNERS:

"If you want to know more about Hunter Douglas Cold Forgings write on your company letterhead for this free 40 page book, just off the press!"

Hunter Douglas Corporation

HUNTER DOUGLAS CORPORATION • DEPT. PE-12 RIVERSIDE, CALIFORNIA TELEPHONE OVerland 3-3030

Precision Dyna-seals seal the "eye" of the Seawolf

DYNA-SEAL

One piece seal provides leak-proof lock washer action—protects vital equipment.

The use of Dyna-seals under bolt heads of the periscope mounting on the nuclear submarine Seawolf will provide positive sealing up to 10,000 P.S.I. Uncompromising requirements of the Precision Dyna-seal were controlled by rigid specifications.

Use performance proved Dyna-seal to solve your problem. Its one piece bonded steel and synthetic rubber construction provides economy and dependability . . . eliminates special machining and over torquing of bolts . . . assures vibration-proof lock washer action!

Compression molded Precision "O" Rings protect Seawolf fuse boxes. Controlled quality, assured through rigid specifications and inspection, is your guarantee of reliable performance in **your** product.

What is your sealing problem? There's an expert – the Precision Engineer – ready to help you.

Write for your free personal copies of the Precision handbook on "O" rings and the Dyna-seal Engineering Data Book.

Precision Rubber Products CORPORATION

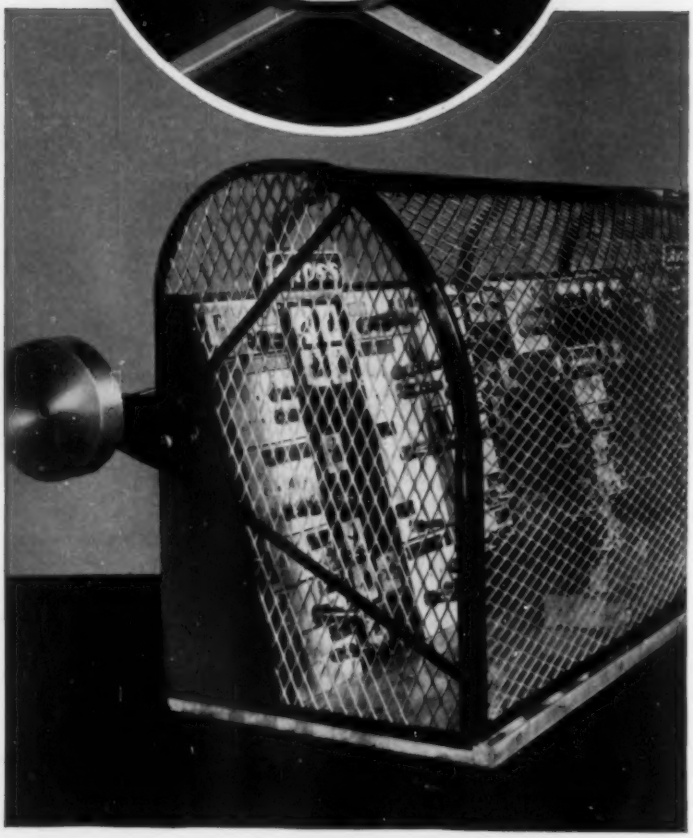
"O" Ring and Dyna-seal Specialists

Dept 3 Oakridge Drive, Dayton 7, Ohio

Canadian Plant at: Ste. Therese de Blainville, Quebec

EXPANDED ALUMINUM...

can it improve your product?



Penmetal expanded aluminum is sheet aluminum, slit and expanded to as much as ten times its original width. As expanded metal, aluminum loses none of its valuable properties. Rather it gains a number of characteristics which make it ideally suited for application to an almost limitless variety of products.

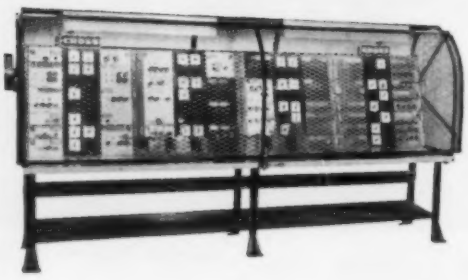
Penmetal expanded aluminum is up to 80% lighter per square foot than the original sheet. Yet it is stronger and more rigid. It permits free passage of light and air, and has that smart, clean, attractive look that typifies modern trends in design.

Besides aluminum, expanded metal comes in carbon steel, stainless steel, Monel, Inconel, and other metals. Large or small mesh; light or heavy gauge. Easily formed, shaped and welded.

Send for new four-page folder which gives mesh sizes, weights and dimensions, and shows a number of profitable ways to use this versatile material.

PENN METAL COMPANY, INC.

General Sales Office:
205 East 42nd Street, New York 17, N. Y.
Plant: Parkersburg, W. Va.



Expanded aluminum used to form a drum type guard over control and tool panel made by Cross Company, Detroit, Michigan.

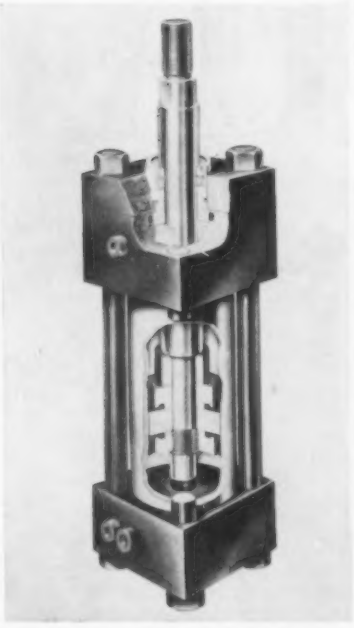
METAL MARK Penmetal 1869 OF QUALITY

PM-7B

cent in 1000 hr. The resistors are virtually unchanging over long periods of time when used at low power with ambient temperatures up to 125C.

Resistance values range from 1 to 2 megohm. Size is ⅜ x ⅞ in. Pyrofilm Resistor Co., Inc., 8 Whippany St., Morristown, N. J.

For more information—
Circle 65, inside back cover



Standard Air-Hydraulic Cylinders

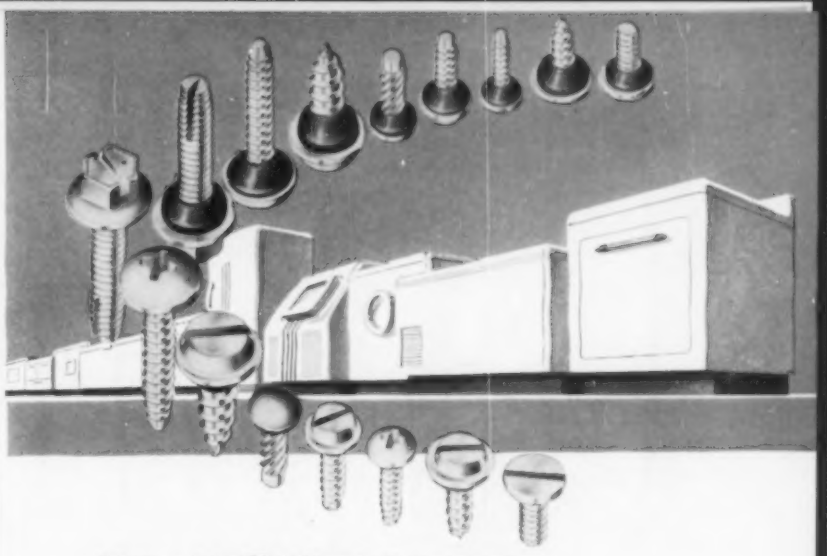
These cylinders are said to have case-hardened, chrome-plated piston rods, Teflon rod wipers, Teflon hydraulic rod seals, and ferric oxide surfaces. The wipers and seals are said to withstand temperatures from −100 F to 500 F, and to be impervious to practically all known chemicals including the fire-resistant, special and standard hydraulic fluids in current use. Miller Fluid Power Co., 2040 N. Hawthorne Ave., Melrose Park, Ill.

For more information—
Circle 66, inside back cover

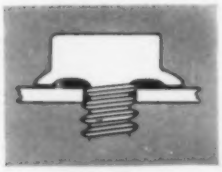
Flanged Bearing Liners

These recently announced Nylon bearing liners are dimensionally the same, the difference being that Type 6 is provided with an anti-rotation

(Continued on page 279)



New Tuff-Tite* Fastener
Is Leakproof—Holds Securely
—Protects Surfaces



Neoprene washer trapped under head seals hole—acts as cushion.

Tuff-Tite is a new multi-purpose fastener that gives tight, leakproof seating without cracking or chipping porcelain enamel and other fine finishes. It also dampens vibration by acting as a shock absorber and eliminating squeaks and chatter.

All this is accomplished by Tuff-Tite's one-piece metal head and assembled neoprene washer. When tightened, the neoprene is trapped and controlled by an undercut in the washer head.

**Trademark*

The neoprene is forced into the hole and around the threads to provide a cushion which protects the surface and forms a watertight and airtight seal.

Tuff-Tite fasteners are used for quick, secure, leakproof fastening of metals and plastics. They are available as tapping screws, thread cutting screws, drive screws, machine screws, stove bolts, wood screws and special fasteners. They are made of carbon, alloy and stainless steel, aluminum, brass and other metals in a variety of head styles.

To learn more about how Tuff-Tite can give you leakproof surface protection with economy, use the coupon below.

THE FASTENING AUTHORITY

Townsend

COMPANY • ESTABLISHED 1816

NEW BRIGHTON, PENNSYLVANIA

Sales Offices in Principal Cities

Cherry Rivet Division, Santa Ana, California

TOWNSEND COMPANY
Sales Department
New Brighton, Pa.

Please send to me without obligation "Tuff-Tite" Bulletin TL-97.

Name_____ Title_____

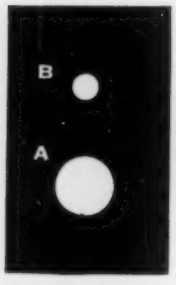
Company_____

Street_____

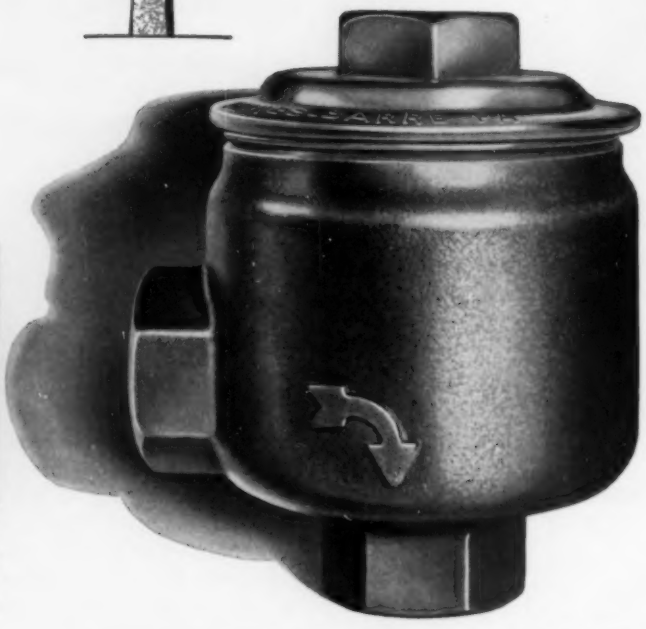
City_____ Zone_____ State_____

TALK ABOUT

Capacity



Discharge orifice of 1" NICHOLSON trap (A) compared with other types of same size (B). Nicholson's greater—in every size!



Compare capacity of a Nicholson Steam Trap with any other trap of same size. Greater capacity—right across the board—means Nicholson Industrial Traps discharge condensate and air from steam lines and process equipment *faster*, more *effectively*. In toughest steam-using equipment service, Nicholson's pay off 4 ways:

- **lower initial cost—more for the money**
- **less upkeep expense—minor maintenance**
- **faster warmup—high, even temperatures**
- **faster production—increased 20% to 30%**

Where performance counts, specify Nicholson. Write for *Catalog 953*.

NICHOLSON

W. H. NICHOLSON and Company

TRAPS • VALVES • FLOATS • METAL PARTITIONS

14 OREGON STREET, WILKES-BARRE, PA. • SALES AND ENGINEERING OFFICES IN 58 PRINCIPAL CITIES

PRODUCT SALEABILITY IS A BASIC REQUIREMENT OF SUCCESSFUL DESIGN

Resistance welding helps you improve your product design

STRENGTH

Resistance welds are stronger than either of the metals welded together. After 10 years of exhaustive tests no other joint survived, practically all automobile manufacturers have adopted resistance welded wheels. The wheels are made with 8 spot welds instead of the 12 conventional rivets . . . using Sciaky equipment.

RESISTANCE TO CORROSION

Resistance welding leaves no exposed metals to corrode, because the weld is within the metals. There are no holes and the joint is tight. However, tight fit-up cannot always be maintained for riveted joints or rivet heads. The result is penetration of atmospheric moisture and corrosion.

LACK OF DISTORTION

Properly applied, resistance welding practically eliminates warpage and distortion. Thus, costly jigs and fixtures to reduce distortion are not necessary on products designed for resistance welding. However, fusion welding produces considerable distortion and does require the extra expense of related fixturing.

LEAKPROOF

With resistance welding there is no hole . . . thus it is leakproof. Actually, resistance welding is commonly used to make gastight seams. However, riveted assembly is inherently subject to leakage. Not only costly to make leakproof, it is sometimes even impractical.

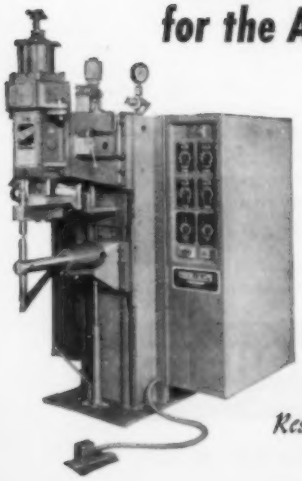
REDUCTION OF WEIGHT

Nothing is added to make a resistance weld—no rod, flux, rivets, etc., are needed. The parent metals themselves are fused together. Resistance welding a product provides a considerable savings in weight compared to riveting, or other forms of welding.

IMPROVED APPEARANCE

Resistance welded spots can be made practically invisible. They need not mar exterior surfaces as do other forms of welding or riveting. Surfaces requiring smooth finish and attractive appearance are best designed for fastening with resistance welding.

Specify Sciaky Patented Three-Phase Resistance Welding for the Advantages of Economy and Consistent Weld Quality



Pioneered, invented, and patented by Sciaky, the three-phase principle of welder operation allows a balanced current to be drawn from all three phases of the power supply.

The result is the lower operating cost of reduced power demand . . . the lower installation costs of smaller switch gear and smaller distribution lines . . . and the consistency of suitable weld quality under high production conditions. For detailed explanation of these and other impressive advantages of Sciaky patented Three-Phase operation, write for Bulletin 332.

Detailed examples of Sciaky resistance welding applications are available in regular issues of "Resistance Welding at Work." Read how other companies large and small have improved their product and lowered fabricating costs. Send your name and title on company letterhead for these impressive examples of Sciaky's basic thinking—welders designed to do *more useful work* at *lower operating costs* with *maximum reliability.*

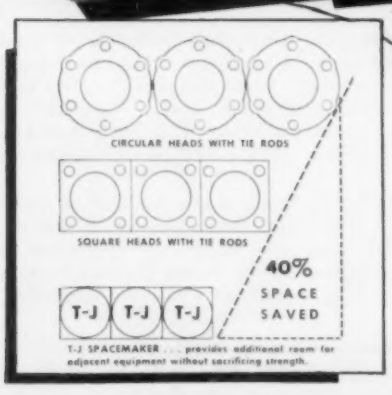
Largest Manufacturers of Electric Resistance Welding Machines in the World

SCIAKY®

Sciaky Bros., Inc., 4913 West 67th Street, Chicago 38, Ill., Portsmouth 7-5600

DELIVERY OFF THE SHELF

IN 64,000 COMBINATIONS


CIRCULAR HEADS WITH TIE RODS
SQUARE HEADS WITH TIE RODS
40% SPACE SAVED
T-J
T-J
T-J
T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

See us in Fluid Power Area ASTE Show Booth 225

T-J Spacemaker CYLINDERS

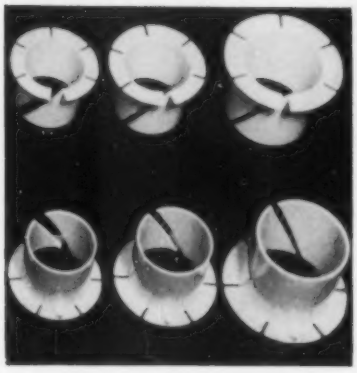
OUTMODE ALL OTHERS . . . SAVE 40% SPACE!

You'll never go back to tie-rod cylinders, once you apply T-J Spacemakers to your push-pull-lift jobs! Advantages in space saved, weight saved, greater strength and off-the-shelf delivery are among the dozens of Extras you get as Standard!

Now — these sensationally popular T-J Spacemaker Cylinders are available off the shelf *in sizes up to 8"*. This means as many as 64,000 different combinations of styles, bores, strokes, mountings, etc. *immediately available!* Oil pressure to 750—Air to 200 P.S.I. Super Cushion Flexible Seals for Air . . . New Self-Aligning Master Oil Cushion. Hard chrome plated bodies and piston rods (Standard). Only from T-J can you get these new ingenious cushion designs! Send for bulletin SM-155-2. The Tomkins-Johnson Co., Jackson, Mich.

Member of the National Fluid Power Association

T-J TOMKINS-JOHNSON
RIVITORS . . AIR AND HYDRAULIC CYLINDERS . . CUTTERS . . CLINCHORS



key for use in soft non-ferrous housings to avoid wear in the event of liner rotation. Each of the two standard series comprises twelve sizes ranging from $\frac{3}{8}$ to $1\frac{1}{2}$ in nominal ID. The length, exclusive of the flange thickness, is the same as the inside diameter. Thomson Industries, Inc., Manhasset, N. Y.

For more information—
Circle 67, inside back cover

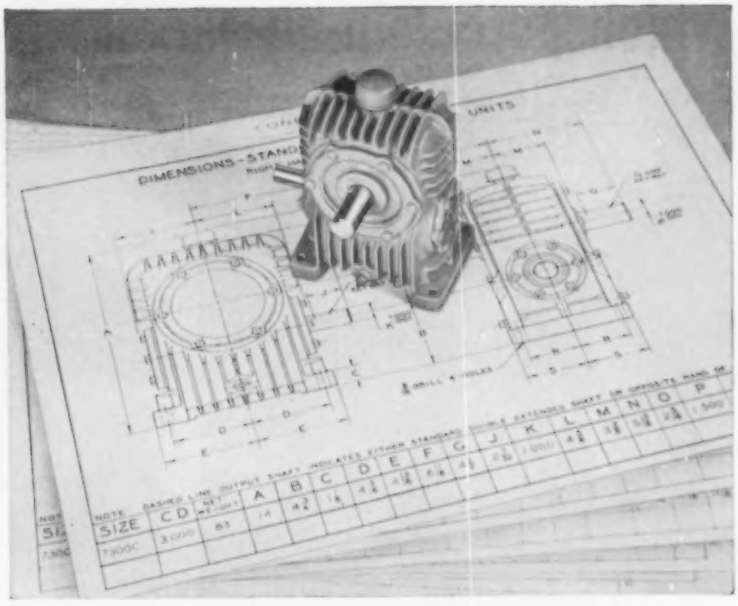
Paste Solder Contains Own Flux

This solder contains flux, making possible a solder job where it is impossible to clean surfaces adequately. It is applied like butter.

To solder any metal the surface oxide must be suspended by the chemial action of the flux. This causes residue. Add dirt from uncleaned metal surfaces and a further barrier is set up for solder to penetrate and bond to the metal. This new preparation is said to overcome this with dual action.

The flux cleans away the dirt and suspends the surface oxide. The chemical envelope around the solder

(Continued on page 282)



DIMENSIONS ONLY TELL HALF THE STORY...

. . . about worm gear speed reducers. You've got to compare size with load capacity for the whole picture. Inside a Cone-Drive speed reducer you'll find the double-enveloping worm gear design that makes it the most efficient right-angle speed reducer available.

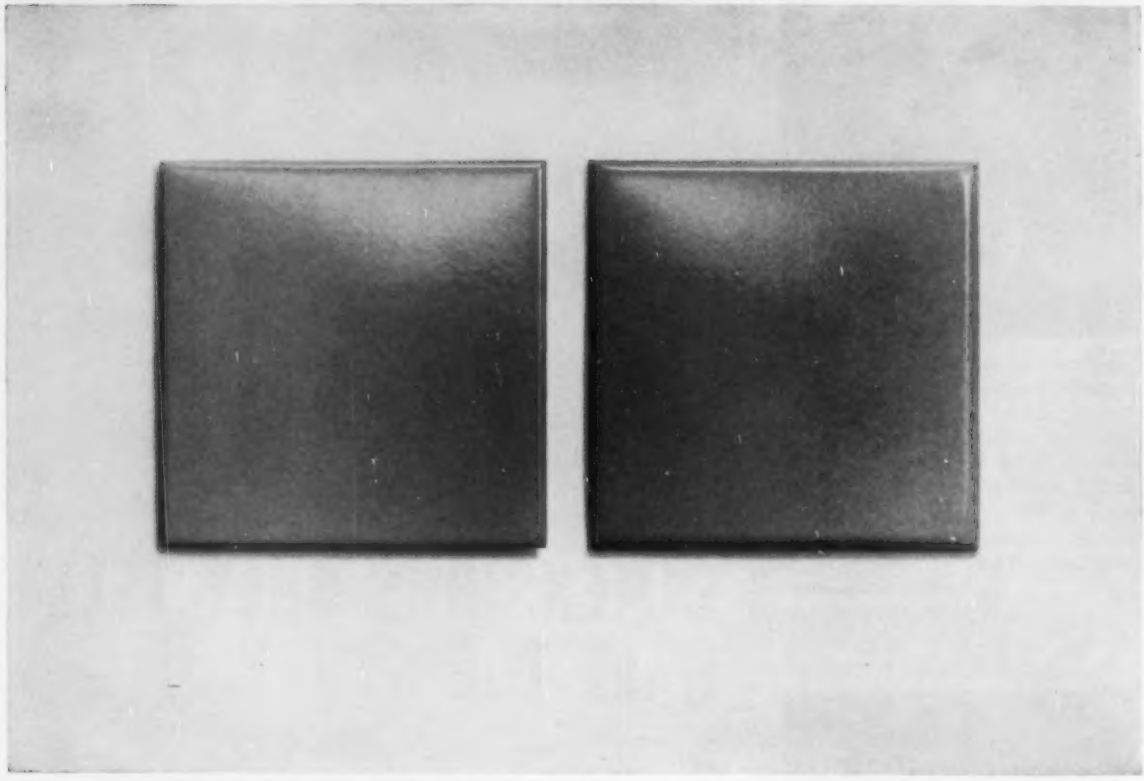
Take the standard 3" center distance unit above for example. Here are its Class I Service Ratings with a 5:1 reduction:

Worm RPM	100	200	300	580	720	870	1150	1750
Mech. HP	1.24	2.21	3.08	4.89	5.61	6.34	7.41	9.04
Thermal HP	1.24	2.21	3.08	4.20	4.62	5.10	6.00	7.80
Output Torque (inch-lbs.)	3340	3010	2830	2405	2250	2150	1940	1575

That's a lot of capacity for a unit that occupies less floor space than this magazine page. But it's typical of Cone-Drive speed reducers and gearsets. Complete details on this model in Bulletin 600-C. Other units to 800 HP and ratios to 4900:1.

CONE-DRIVE GEARS
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
Division Michigan Tool Company
7171 E. McNichols Road • Detroit 12, Michigan

Which porcelain-on-aluminum tile is prefired?



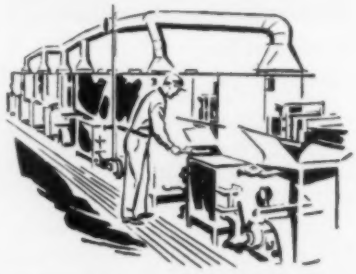
THE TILE AT THE LEFT HAS BEEN PREFIRED . . . the one at the right Alodized with Alodine and enameled without prefiring. Although the prefiring operation has been eliminated, there is no loss of quality in the finished product. This is another first for Vikon, which introduced porcelain-on-aluminum tile.

Vikon Tile Corporation applies Alodine® coating to eliminate prefire cycle—makes substantial saving without sacrificing the fine quality or the permanency of its porcelain-on-aluminum tile.

In the 6-stage Alodizing process developed by ACP for Vikon, the 3S aluminum half hard coil stock is cleaned, treated with Alodine 1200, and dried. Residues and contaminants are completely removed to provide a perfect base for the porcelain finish. And no expensive prefire operation is required to maintain the uniformly fine quality of the finish. Not only did ACP provide the method for preparing the aluminum strip for finishing, but it solved the problem of preventing contamination of the tile during the stamping operation.

Tests of finished tile have shown that there is no spalling and no fracturing of the porcelain. Color matching is no problem, and rejects due to contamination are extremely low.

Still another advantage of this newly developed process for the manufacture of porcelain-on-aluminum tile is offered by ACP. Its Service Department will make periodic inspection of the process in operation and of the equipment. And its Quality Control Laboratories will run tests of finished coupons. Both are free of charge — added services that keep the Alodizing process working effectively.



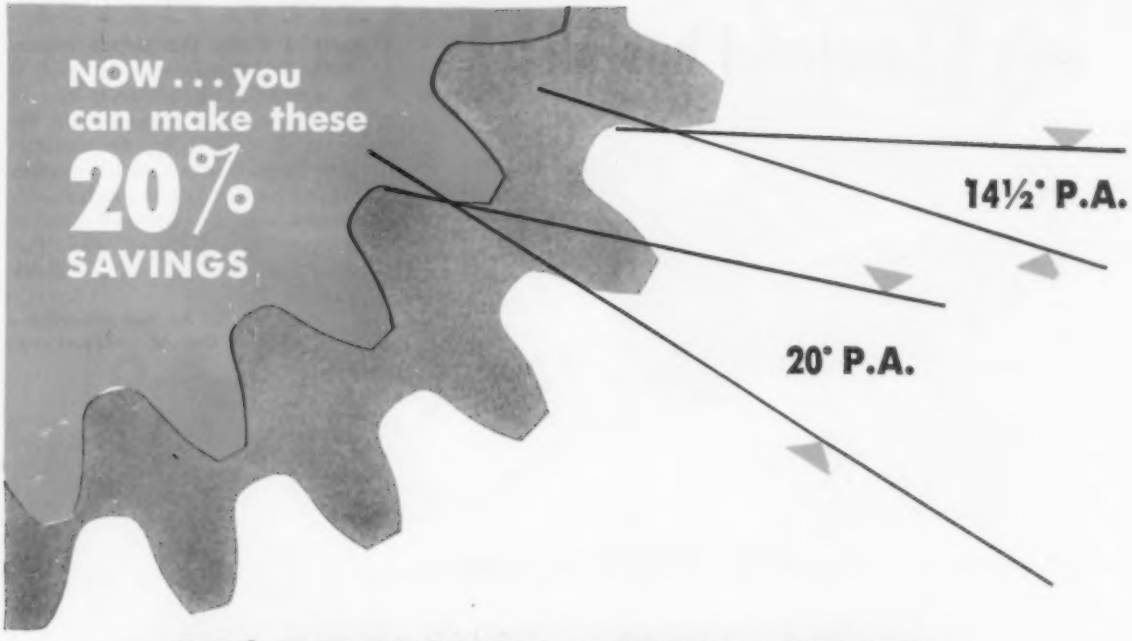
THIS 6-STAGE ALODIZING MACHINE cleans, treats and dries the 3S aluminum strip. Residues and contaminants are completely removed so as to provide a perfect base for the finish.

Write us for Bulletin 1241A. It gives complete information about Alodizing with Alodine

AMERICAN CHEMICAL PAINT COMPANY, Ambler 17, Pa.

DETROIT, MICHIGAN NILES, CALIFORNIA WINDSOR, ONTARIO

CHEMICALS ACP PROCESSES



with 20° PRESSURE ANGLE GEARS

BOSTON GEAR now offers 441 Standard Stock Sizes

Every engineer knows the mechanical advantages of the 20° P.A. tooth form. It's the standard for automotive drives, and wherever highest efficiency, with economy of space, weight, and cost are essential.

Now, BOSTON GEAR has the answer to the question of *availability*. A full range of *standard stock* sizes, supplied by all BOSTON GEAR Distributors, makes it practical to specify the 20° P.A. for virtually all spur, bevel, and miter gear applications.

Start making this big saving you've been missing. For details, call your BOSTON GEAR Distributor, or write: Boston Gear Works, 71 Hayward St., Quincy 71, Mass.

SAVE 20%
IN SPACE, WEIGHT, AND COST

COMPARE: SAME RATIO SAME HP

Example:

	14½° P.A.		20° P.A.	
	Pinion	Gear	Pinion	Gear
Pitch Diam.	2"	8.4"	1.66"	7.00"
Center Distance	5.200		4.333	
Weight	1 lb.	7½ lbs.	¾ lbs.	5 lbs.
List Price	1.95	8.65	1.70	6.70

BOSTON GEAR CATALOG lists Standard Stock Sizes of 20° P.A. Spur, Bevel, and Miter Gears, along with the conventional 14½° P.A. Gears for every requirement. Ask for your copy.

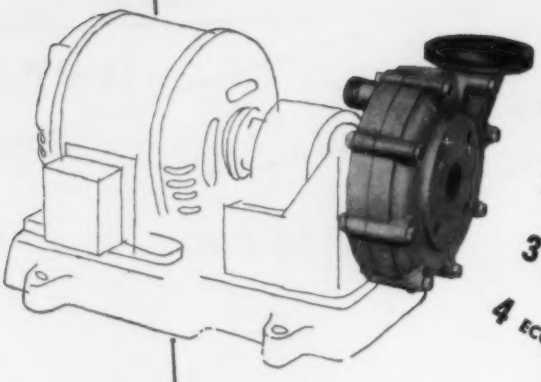
Call your BOSTON Gear® DISTRIBUTOR

For nearest Distributor, look under "GEARS", in the Yellow Section of your Telephone Directory

7124 "OFF-THE-SHELF" TRANSMISSION PRODUCTS FROM YOUR LOCAL DISTRIBUTOR — AT FACTORY PRICES

568G-G-18

only 1 material has all 4



...for ACID PUMPS for instance

One of the strongest plastics known . . . .Ace Hard Rubber . . . got the nod for the impeller and casings of this acid pump. Why? (1) It's resistant to almost all corrosives; (2) High strength and abrasion resistance; (3) Won't warp or swell; and (4) Costs much less than corrosion-resistant alloys. Typical result: On one job this hard rubber pump handles 12% hydrofluoric acid, turns on and off twice a minute, 24 hours a day, six days a week . . . a mighty tough test for corrosion-resistant materials?

Many other Ace hard rubber compounds are available . . . tensiles as high as 10,000 psi, moisture absorption as low as 0.04%, power factor as low as 0.006, heat resistance to 300 Deg. F. . . . also many new plastics and rubber-resin blends. All Ace compounds are tailor-made to fit the job . . . never *over*-designed. That's why Ace is the *only* material that meets all four big requirements for parts like acid pumps.

and here's a 5th

Hard rubber sleeve provides electrical insulation as well as mechanical and chemical strength in this coupling for electroplating agitator.

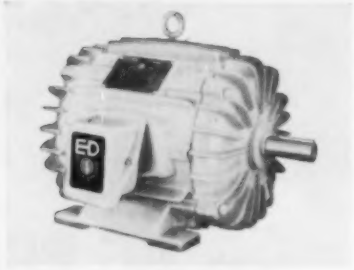
80-pg. Ace handbook free to design engineers.

ACE® rubber and plastic products

AMERICAN HARD RUBBER COMPANY
93 WORTH STREET • NEW YORK 13, N. Y.

particles lowers the surface tension of the solder and metal to which it is applied. This releases a rain of solder particles to uniformly coat the metal. Tests indicate, the manufacturer states, that this method doubles the area possible to solder with a given amount, over the standard method of applying flux and adding solder. Farrelloy Co., 1241 N. 26 St., Philadelphia 21, Pa.

For more information—
Circle 68, inside back cover



Totally Enclosed, Non-Ventilated Motor

A rerated, totally enclosed, non-ventilated, fan-cooled motor conforming to the dimensional standards recently adopted by NEMA has been placed in production. Housing and end brackets are cast iron, ribbed. The new motor is designed for operation where non-combustible dust and moisture are prevalent. Frame sizes 182, 184, 213 and 215 are currently in production. Electro Dynamic Div., General Dynamics Corp., Bayonne, New Jersey.

For more information—
Circle 69, inside back cover

Miniature Resistors for Printed Circuits

These resistors are single-ended units made for rapid mounting on printed circuit panels with no support other than their wire leads. They can be safely operated at full-rated load in ambient temperatures up to 125 C. These resistors are made with high temperature epoxy resins and resistance wire with special high temperature insulation. Sizes are available rated at from $\frac{1}{10}$ up to 1 w.

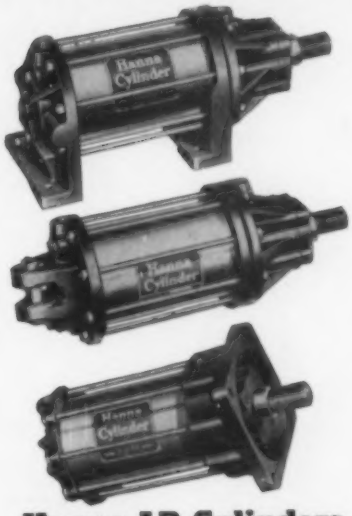
The type P resistors are available in

(Continued on page 284)

HANNA AIR and HYDRAULIC CYLINDERS

Hanna T 750 Fluid Power Cylinders

Air Operation to 250 psi, Hydraulic Operation to 750 psi
Write for Catalog 750A



Hanna LP Cylinders

Air or Hydraulic Operation to 110 psi
Write for Catalog 236B

Here's Everything You Need

Smooth, Dependable Power Packaged As You Want It

■ "Good things come in small packages," it is said . . . so do Hanna Cylinders . . . and in medium and large packages, too. From the complete Hanna Cylinder line, up to 1,500 psi capacities, you can select a standard size and mounting style, with the power and stroke you need, to exactly suit your applications. Of course, you will be sure it's the finest cylinder for the job—because it's a Hanna. Well over fifty years of design and manufacturing experience guarantee that.

So, when you need reliable cylinders for products you make for resale, or for use in your own plant, consult a Hanna representative, or call on our plant engineers to help you find the most efficient answer to your problem. Also write us for technical literature.

Hanna HP Cylinders

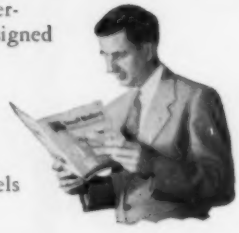
Hydraulic Operation to 1,500 psi
Write for Catalog 233B

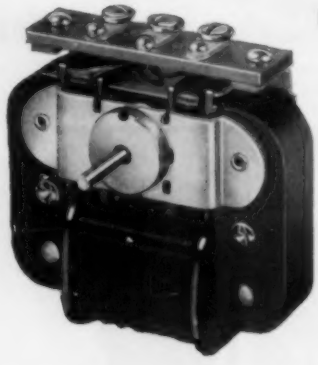
Hanna Engineering Works
1763 Elston Avenue, Chicago 22, Illinois

BARBER COLMAN **Small Motors**

new free catalog helps select exact motor needed

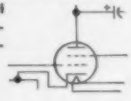
Get this helpful new catalog of Barber-Colman a-c shaded pole motors. Designed for applications requiring long life, rugged construction, these quality motors with high starting torque, low-inertia rotors provide quick, positive starting under adverse conditions. Various models of the four types shown below.

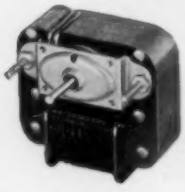




REVERSIBLE MOTORS

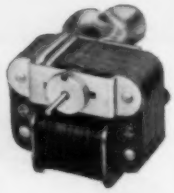
Adaptable to a variety of control circuits to meet many different requirements demanding a compact and powerful fast-reversing motor. Widely used for servo-mechanisms, remote switching and positioning devices, voltage regulators, pen drives. Available with gear trains, open or enclosed, in wide range of ratios. Low-inertia rotors permitting rapid reversing and follow-up make these motors **ideal for many electronic control circuits.**





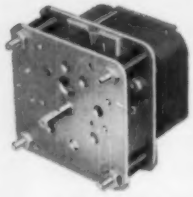
UNIDIRECTIONAL

For driving pumps, projectors, blowers and fans for refrigerators, gear trains for vending and office machines, etc.



SYNCHRONOUS

For chart drives, timers, microfilm cameras, oscillographs, and similar applications.



GEARED

For vending and office machines, rotisseries, TV tuners, program switches, etc. Model shown for overhanging loads.

the complete line of Barber-Colman motors includes unidirectional, synchronous, and reversible motors — up to 1/20 hp. With and without reduction gearing — open or enclosed types. Expert engineering service available to help you get the exact motor for your application. Write today for your free copy of new Catalog F-4271-6.

Barber-Colman Company

Dept. A, 1212 Rock Street, Rockford, Illinois

Small Motors • Automatic Controls • Industrial Instruments • Aircraft Controls • Air Distribution Products
Overdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

six sizes ranging from $\frac{1}{4}$ x $\frac{3}{8}$ in. long to $\frac{3}{8}$ x $\frac{3}{4}$ in. long. Available resistance values range from 0.40 megohm for the smallest size up to 3 megohm for the largest unit. Tolerances available range from 1 to 0.05 per cent. Resistance Products Co., 914 S. 13 St., Harrisburg, Pa.

For more information—
Circle 70, inside back cover

Hose Assembly for —100 F to 500 F

Having a tetrafluoroethylene inner tube and a specially designed detachable, reusable fitting, this assembly is said to possess resistance to acids and other fluids heretofore not transportable by synthetic or natural rubber hose. The reusable fitting can be attached and detached by hand without the use of any special tools. Aeroquip Corp., Jackson, Mich.

For more information—
Circle 71, inside back cover

Fatigue-Resistant Steel Bar

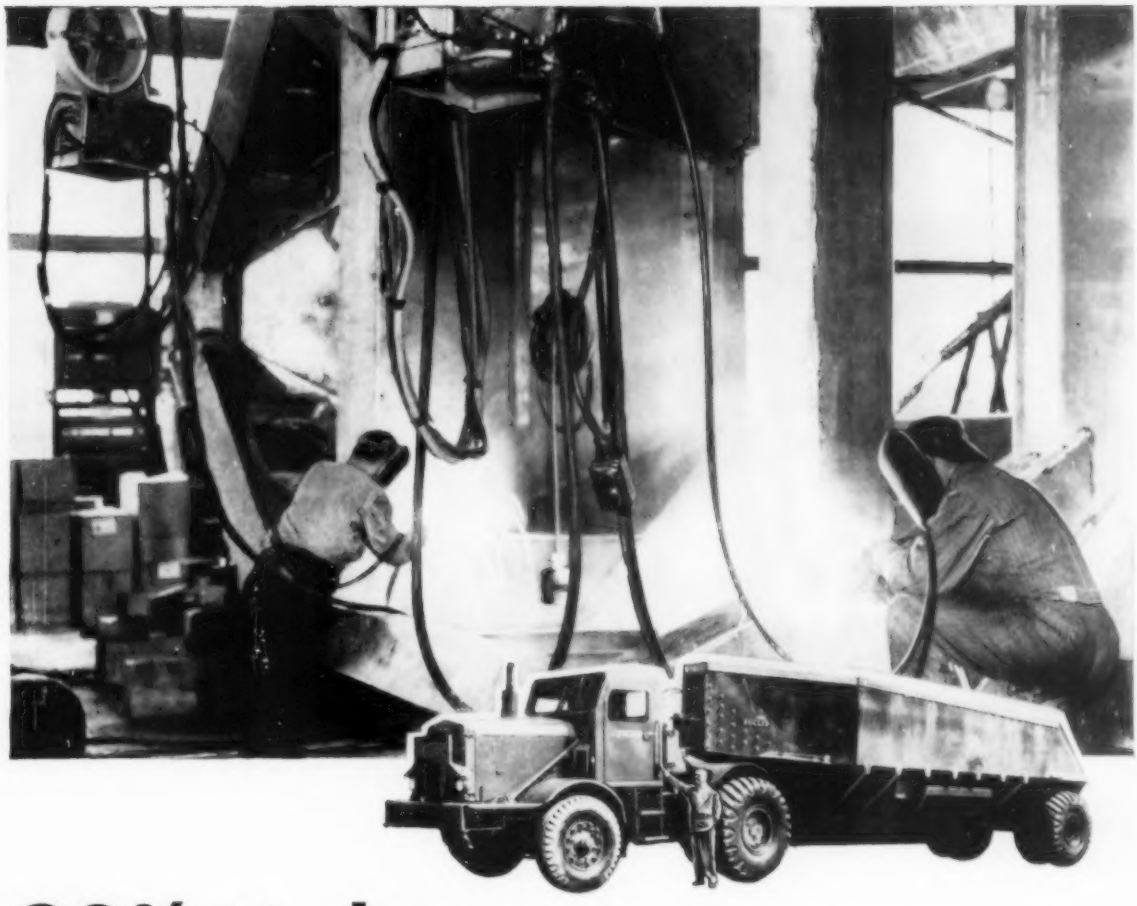
A high-strength, free-machining steel bar which requires no heat treating has properties usually associated only with heat-treated steels, according to the manufacturer. With the heat treating process eliminated, quench cracks are said to be eliminated, along with distortion. Tensile strengths are in the range of 140,000 to 150,000 psi . . . with a hardness related to this strength level of approximately 30 Rc. La Salle Steel Co., Chicago 80, Ill.

For more information—
Circle 72, inside back cover

Servo Control Valves

The Model CO-5 valve is designed for use in follow-up positioning systems where mechanical input signals are obtained from cams or linkages. Positional feedback is obtained through the use of differential input linkages or by displacing the valve body relative to the spool motion. The latter may be accomplished by placing the valve body directly on the

(Continued on page 289)



33% Lighter...

Sigma Welding helps up truck pay-load 5 tons

The less weight consumed in a truck's structure, the more room there is for the all important pay-load. By sigma welding these giant drop-bottom dump trailers of sturdy aluminum alloy, 8,210 lb. dead-weight has been eliminated —and truck capacity increased 5 tons.

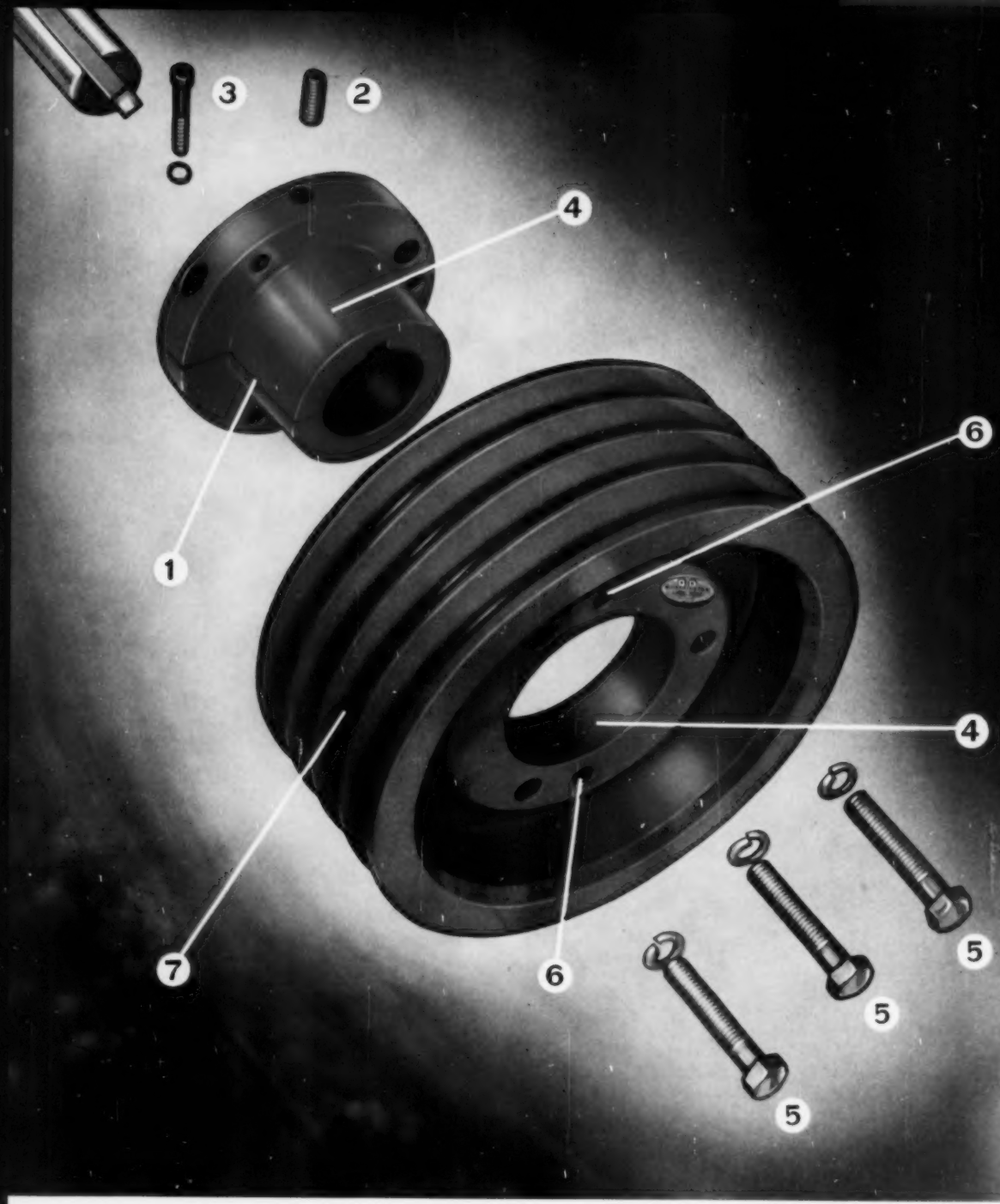
In this operation, sigma rod feed units are suspended above the work area to allow each operator complete freedom of movement with his sigma torch. Sigma welding operations are fast, and finished welds are of highest quality. The 36-ft. long trailers are fabricated of $\frac{5}{16}$ and $\frac{5}{8}$-in. plate, and $\frac{3}{8}$ and $\frac{3}{4}$-in. channel extrusions.

Like many other products throughout industry, these trailers are being fabricated with new quality and efficiency using sigma welding with argon shielding. Sigma welding produces smooth, high-quality welds in all type joints, and exceeds 100 in. per min. in many operations. It is an efficient method for joining such metals and alloys as carbon steel, stainless steel, copper, bronze, aluminum, and unalloyed titanium. Start saving now with greater production speed and unit quality—call your local LINDE representative today.

Linde Air Products Company
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
Offices in Other Principal Cities
In Canada: LINDE AIR PRODUCTS COMPANY
(formerly Dominion Oxygen Company)
Division of Union Carbide Canada Limited, Toronto

The term "Linde" is a registered trade-mark of Union Carbide and Carbon Corporation.

Linde
Trade-Mark



EXPLODED VIEW of Worthington QD Sheave shows design features that make it industry's first choice.

1. **COMPLETELY SPLIT QD HUB** holds shaft tightly under heaviest shock loads.
2. ***CUP POINT SET SCREW** in QD hub keeps shaft key in position.
3. ***CLAMP SCREW** secures hub in proper alignment on shaft when mounting sheaves.
4. **TAPERED FIT** between hub and sheave allows easy-on, easy-off, hold-tight action.
5. **PULL-UP BOLTS** draw sheave on to hub to produce positive fit on shaft.
6. **TAPPED HOLES** in sheave permit pull-up bolts to be used as jack screws to break cone grip when removing sheave.
7. **GROOVE CROSS-SECTIONS** are accurate and uniform so that each V-belt seats properly, pulls evenly.

***All Worthington-Manufactured QD Heavy-Duty Hubs incorporate these exclusive features.**

Who says all sheaves are alike?

Nobody who ever saw the Worthington QD, we wager.

Big difference between the QD (that's short for quick-detachable) and ordinary sheaves is this: the QD is easiest to get on, easiest to get off, yet always grips tightly on the shaft.

Those are the big reasons why design engineers specify more QD's than any other sheave — why the QD will do a *better* job on *your* product.

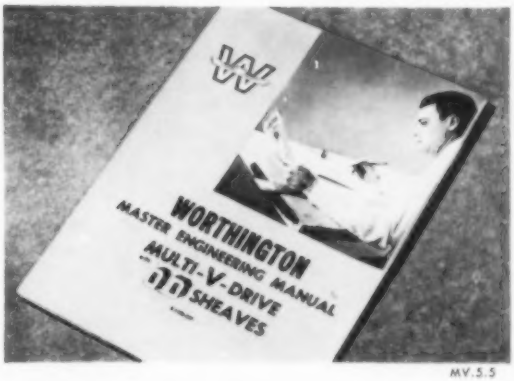
More reasons for standardizing on the QD

SCIENTIFIC DESIGN of Worthington QD Sheaves not only provides more efficient transmission of power but actually adds to the looks of your product. What's more, I-beam construction of the QD DriveN sheave provides greater strength with less weight. You'll find Worthington QD Sheaves a dependable source of trouble-free mechanical power transmission. The large variety of immediately available standard sizes and ratings, for A, B, C, and D section V-belts, makes for a simple, economical solution to your design problem.

PROMPT SHIPPING SERVICE. Thirteen factory warehouses with stocks covering over 100,000 V-belt drive combinations, from ½ to 600 horsepower, support more than 250 distributor outlets. These shipping centers can fill your requirements *fast*.

Warehouses Located at: Kearny, N. J. • Oil City, Pa. • Portland • San Francisco • Los Angeles • Denver • Tulsa • Ft. Worth • Houston • New Orleans • Chicago • Cleveland • Atlanta, Ga.

GOOD NEWS FOR DESIGN ENGINEERS! Now, with Worthington's new 100-page "Master Engineering Manual," you can select the right sheave and V-belt combination for your equipment in *three minutes*. Easy-to-use tables take all the complications out of sheave selection — require only simple arithmetic. Be sure to write for your copy today. It's free, of course. Worthington Corporation, Mechanical Power Transmission Division, Section MV.5.5, Oil City, Pa.

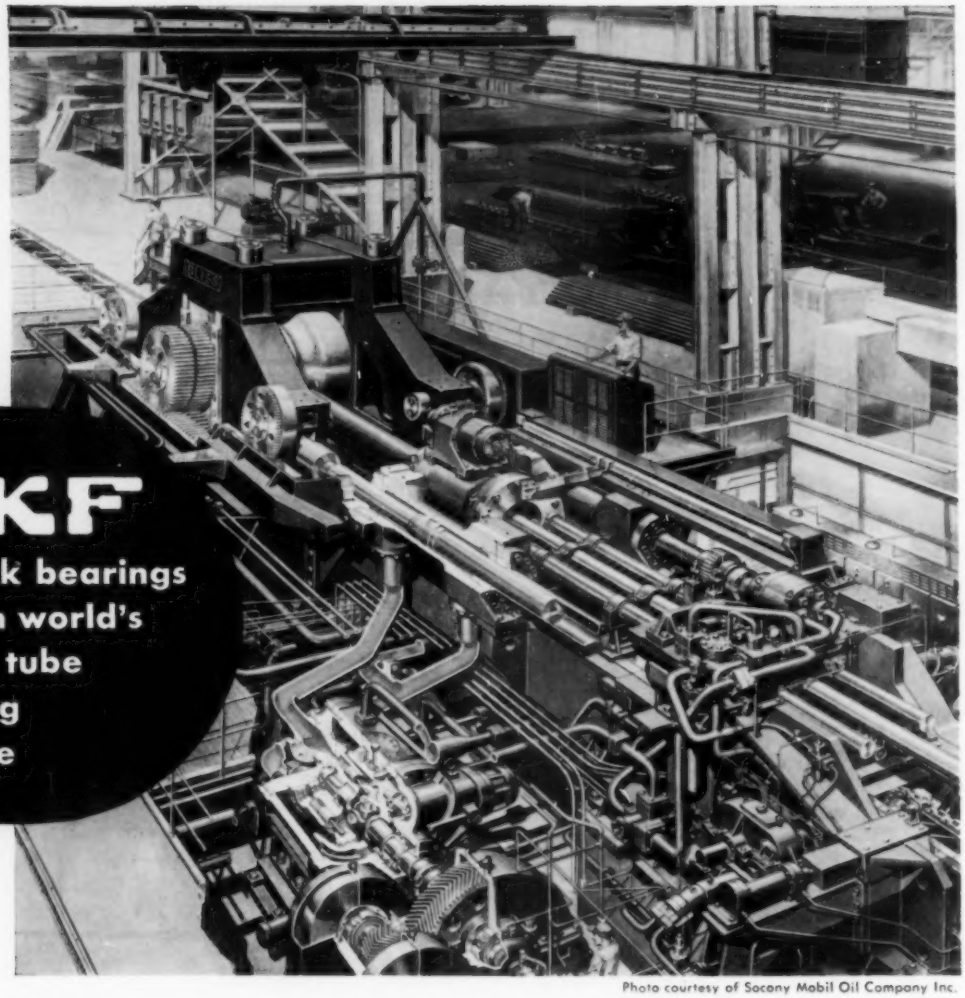


MV.5.5

WORTHINGTON

SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON YOUR EQUIPMENT

Compressors • Pumps • Multi-V-Drives • Variable Speed Drives



SKF

roll neck bearings used on world's largest tube reducing machine

Photo courtesy of Socony Mobil Oil Company Inc.

SKF sphericals absorb tremendous punishment, provide greater bearing capacity

This 102 foot long giant tube reducing machine, designed and operated by Tube Reducing Corporation, Wallington, N. J., for the U. S. Navy Bureau of Aeronautics, and built by E. W. Bliss Company, Canton, Ohio, puts a 3½ million pound squeeze on precision tubing of outer diameter sizes ranging from 9 to 17 inches for military and commercial cold finished tubular products.

The mammoth bearings for 50" diameter rolls on the machine are SKF Spherical Roller Bearings. They are the largest spherical roller bearings of this type ever made, with a rated capacity of 3,200,000 lbs. Each bearing weighs 5150 lbs.; individual rollers weigh 39½ lbs.

The Tube Reducing Corporation first employed SKF Spherical Roller Bearings in 1937 for a 2¼" tube reducing machine having 13" diameter rolls. Today, *all* tube reducers in this plant are SKF-equipped... from the smallest to the 102 foot giant.

Like the men at Tube Reducing Corporation, organizations that pioneer advancements in their fields are accustomed to find that SKF matches their vision with advanced bearing design that helps them make a working reality of their most ambitious and forward-looking plans.

Make SKF Engineering cooperation a *plus* factor in the successful realization of your company's planning and development program. 7851

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA., *manufacturers of* SKF *and* HESS-BRIGHT® *bearings.*

SKF®

BALL AND ROLLER BEARINGS

load cylinder or by mounting the valve body on a slide actuated by the load motion.

Rectangular internal parts are said to provide linear flow at constant pressure drop. Hardened and lapped sleeve and spool construction is standard. All hydraulic connections are grouped at the top of the valve so that multiple installations operated by a number of cams or linkages will occupy as little space as possible. Valve flow vs. displacement characteristics are easily modified to suit individual power and stability requirements. Hydraulic Controls Co., 87 Terrace St., Roxbury 20, Mass.

For more information—
Circle 73, inside back cover

Fast-Drying Enamels

A line of fast-drying synthetic finishes for manufacturers of heavy equipment such as farm and road machinery and machine tools is being introduced. In most colors these enamels set up so rapidly the ware can be handled in about 15 min. The material is tack-free in 2 to 3 hr. E. I. du Pont de Nemours & Co., Wilmington, Del.

For more information—
Circle 74, inside back cover

Variable Speed Pulley

A compound drive provides constant belt alignment through its entire speed range. Using a 1750 rpm motor, a speed range of 5550:690 is obtained at a rated ¾ hp. With an 1150 rpm motor a speed range of 3650:454 is provided at a rated ½ hp.

These pulleys accommodate the new NEMA motor frame shaft sizes and use a $\frac{5}{8}$ in. top width or "A" belt as standard. Available in either spring-

(Continued on page 290)

YOUR BEST BET
for help on your
HOSE PROBLEMS

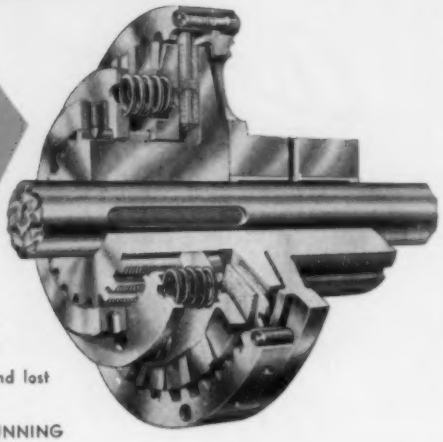
ACME
Hose Products
for
Acid
Air
Brewers
Beverage
Creamery
Dust & Air Duct
Fuel Oil
Garden
Gasoline
Paint & Solvent
Rock Wool
Sand Blast
Spray
Steam
Steam Iron
Suction
Swimming Pools
Tubing,
Cloth Inserted
Vacuum
Waste Disposal
Water
Welding

Your ACME man has a bag full of ideas on how to cut costs, improve the product, add sales appeal with ACME RUBBER HOSE. He has behind him 53 years of ACME research, engineering and development in all types of hose. Put this know-how to work on your problems and get the top return for your hose dollar.

PUT THE JOB
UP TO.....
Acme
HOSE SPECIALISTS
ACME RUBBER MANUFACTURING CO.
1431 EAST STATE STREET TRENTON, N. J

HILLIARD *Clutches*
FOR POWER CONTROL DESIGN

ADJUSTABLE
Slip Clutch



- PROTECTS against overload, jams and down time.
- RESUMES THE DRIVE AUTOMATICALLY after overload.
- ELIMINATES SHEAR PINS and lost time.
- ADJUSTABLE - WHILE - RUNNING feature is available.

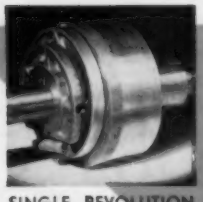
Hilliard Slip Clutches are continuously protecting the drive on dish washing machines—printing presses—packaging machines—case loaders—foundry equipment— air filters—conveyors—overhead doors—and many others.
They maintain steady torque while permitting speed variation on fabric drying drums, steel strip slitters and similar equipment.

The adjustable-while-running types are used to maintain constant tension on rewind stands for paper coaters, textile machines, rope, steel and wire mills and for drive systems requiring overload protection but which must be disconnected at times.

WRITE TODAY FOR BULLETIN 300 WITH COMPLETE INFORMATION.

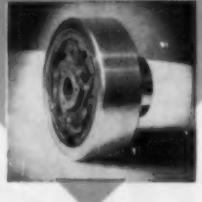
● OTHER HILLIARD CLUTCHES ●

CONSIDER AUTOMATION - INVESTIGATE THESE PRODUCTS



SINGLE REVOLUTION CLUTCHES for automatic accurate control —electrical or mechanical—of intermittent motion, indexing, cycling and cut-off. Ask for Bulletin 239.

HILLIARD - TWIFLEX CENTRIFUGAL COUPLING for smooth, easy starting of any load automatically with overload protection and ability to accommodate shaft misalignment. Ask for Bulletin CE-3.



OVER - RUNNING CLUTCHES for automatic instantaneous engagement and release on two speed drives, dual drives and ratchet, or backstop action. Ask for Bulletin 231.

THE HILLIARD *Corporation*
MANUFACTURING CLUTCHES FOR OVER 50 YEARS

101 W. FOURTH ST. ELMIRA, N. Y.
IN CANADA: UPTON • BRADEEN • JAMES, LTD.

loaded or manually operated design, they can be mounted on one side or alternate sides in accordance with installation requirements. Where mounted on one side, the spring-loaded design measures 6½ x 5 in. long, while the manually operated design measures 6 x 3⅜ in. long. Lovejoy Flexible Coupling Co., 4873 W. Lake St., Chicago 44, Ill.

For more information— Circle 75, inside back cover

Air Cylinders

Available in three basic styles, standard, adjustable and adjustable-retractable, these cylinders are coupled with six different types of mounting, either single or double rod-type. Parts for all models, cushioned or non-cushioned, are interchangeable. Taylor-Winfield Corp., Warren, Ohio.

For more information— Circle 76, inside back cover

Regulated Power Supplies

All four models in this series have ripple less than 1 mv rms. Ready to connect to circuitry, all connections are made on terminal strip. Either positive or negative polarity with respect to ground is available. Hamner Electronics Co., Inc: P. O. Box 531, Princeton, N. J.

For more information— Circle 77, inside back cover

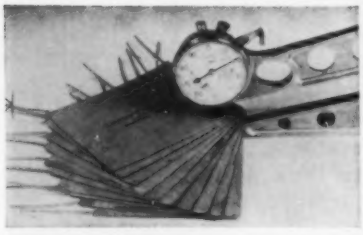
Electronic Counting System

Capable of 125 counts per second, this industrial counting system is said to be compact enough for location at any convenient spot, simplified enough for installation and servicing by plant electricians. Cast aluminum houses the system's light source and photocell

(Continued on page 291)

pickup units. Its high speed counter is in a heavy waterproof case with tamperproof, transparent cover. Distance between light source and photocell can be varied from 3 in. to 6 ft. Dept. NR 32, Berkeley Div., Beckman Instruments. Inc., 2200 Wright Ave., Richmond 3, Calif.

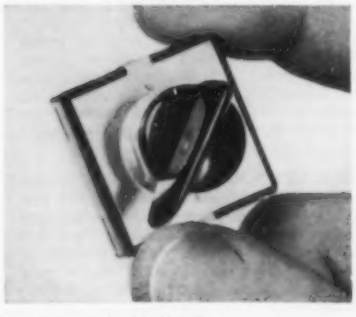
For more information—
Circle 78, inside back cover



Heating Elements 0.032 in. Thick

These heating elements are designed for use in electronic equipment, crystal ovens and in other applications where excessive thinness is a requirement. Insulation of silicone rubber and glass fiber can be operated at temperatures in excess of 450 F. Elements are produced in any plane shape and in any size required. Resistance variation offered is from 1.5 to 40 ohm per square inch. Electro-Flex Heat, Inc., Dept. D-10, 516 Asylum St., Hartford 5, Conn.

For more information—
Circle 79, inside back cover



Rotary Switch for Small Appliances

An enclosed, nozzle-mounted rotary switch for electric fans and other small appliances has a pressure lock arrangement that is said to simplify wiring connections. The prepared

(Continued on page 295)

NOW A 1/4" DIAMETER SEAMLESS METAL BELLOWS

Bridgeport Thermostat's broad experience in bellows engineering now makes available 1/4" and 5/16" diameter bellows. Ideally suited to miniaturization, these tiny units are produced in a wide range of characteristics and metals. Bridgeport specializes in metal bellows and complete bellows assemblies of all types and sizes. Send for new bellows engineering data—use handy coupon below.

Robertshaw-Fulton
CONTROLS COMPANY
BRIDGEPORT THERMOSTAT DIVISION • MILFORD, CONN.

Send me the Bridgeport bellows data checked below: (Dept. AP-1400)

☐ Full details on new, small-diameter bellows
☐ Bellows Engineering Bulletin #125 (28 pages)

NAME_____
COMPANY_____
ADDRESS_____
CITY_____ STATE_____

EXPERTS AGREE "DO-IT-YOURSELF" FINE FOR HOME, but UNSUITABLE FOR INDUSTRY

It is the consensus of experts that the "Do It Yourself" trend is a fine thing for hobbyists, but in industry it can be uneconomical and inefficent.

This makes sense. When it comes to something technical and precise, such as a tiny component of a product, no one can do the job as well as a specialist.

And when it comes to tiny die cast parts, no one can do the job as well as Gries. This is because Gries specializes in the precision molding of die cast zinc alloy tiny parts. GRC has unique machines which produce simple or intricate parts—even movable multiple-element assemblies—*in one automatic operation*. This completely automatic production is fast and economical.

Many manufacturers, seeking to cut down overhead and achieve the most efficient operation, have found that the specialized services offered by Gries save them time and money, and give them parts which perform better because they are made better.

GRC SOLVES TOUGH PARTS PROBLEM

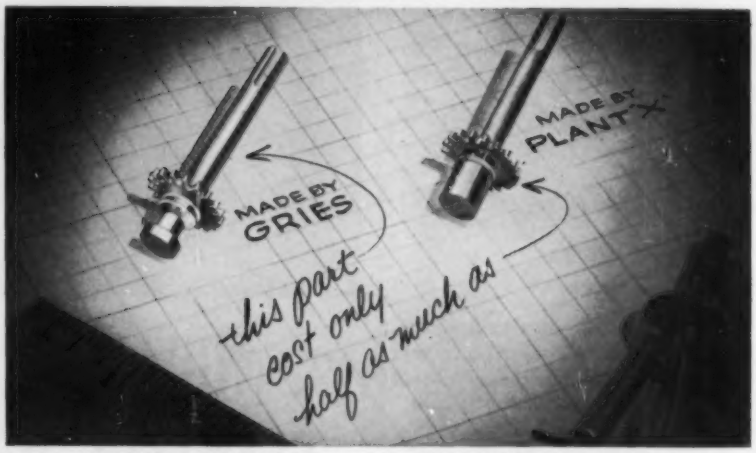
Even the most hard-to-make parts—parts that are too difficult for conventional die casting—are produced by Gries' exclusive methods. Intricate shapes and involved contours are mass produced in one continuous operation.

This gives design engineers unlimited latitude in planning products which use small parts. It decreases the number of operations; often completely eliminates machining and assembly work. Unlike other methods, there is no scrap loss.

GRIES OFFERS INFORMATIVE DIE CASTING BULLETIN

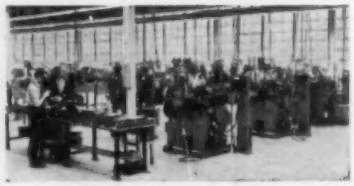
Write, wire or phone today for your copy of Gries' fact-filled Die Casting Bulletin. It gives specific information which will show you how Gries can help you with your small parts problems. Send prints for quotations.

For example, cost and delivery comparisons prove that Gries can die cast tiny parts more economically and more efficiently than most "captive" plants.



Gries-made SLOTTED GEAR SHAFT for range timer, at left, cost half as much as part made by Plant "X", at right, and can be used in a number of additional applications.

EXCLUSIVE PRODUCTION FACILITIES OFFERED BY GRIES



At the modern Gries plant in Westchester County, New York, production facilities are geared to turn out quantities of 100,000 to many millions, completely trimmed and degated, ready for use. Smallness is unlimited; maximum weight ½ oz., maximum length, 1¾ in.

Gries also has full facilities for secondary operations such as tapping, drilling, assembling, reaming, special machining and surface finishing. Practically all commercial finishes can be applied in our complete plating department.

GRIES' TINY MOLDED PLASTIC PARTS DESCRIBED IN NEW BULLETIN

In addition to die casting tiny parts, Gries also molds all thermoplastics—Nylon, Kel-F, acetates, polystyrene, polyethylene, etc. A new bulletin is now available giving details of Gries' simplified methods for automatic injection molding and exclusive insert molding.

This bulletin describes how the unique techniques developed by Gries make possible tiny plastic parts to precise size and design specifications. You may find that Gries plastic parts are the answer to your production problems. Send for your copy of the Gries Plastics Molding Bulletin *TODAY*.

WORLD'S FOREMOST PRODUCER OF SMALL DIE CASTINGS

GRIES

GRIES REPRODUCER CORP.

159 Beechwood Ave., New Rochelle, N. Y. NEw Rochelle 3-8600

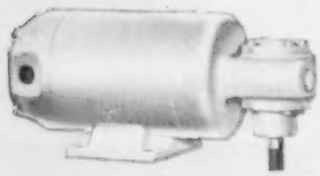
when you need a *Special* motor...contact DOERR

Over 95% of Doerr's production consists of motors with one or more special features

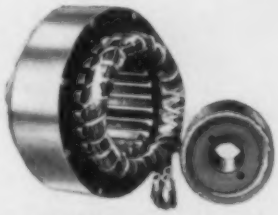
Rely on Doerr's long and specialized experience to solve your problems. List your specifications. Then let Doerr prove how easy it is to select and receive on-time delivery of motors that *exactly* fill your need.

Special features and modifications of all types are available. Present castings, windings and mountings can be adapted to solve new design problems at minimum cost. In addition, Doerr makes a complete line of standard NEMA ratings, every motor precision-built to the highest standards of quality.

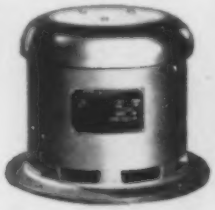
Discover now why leading machinery builders consistently re-order Doerr Motors. Before you buy, just write or call us in for a talk. More than likely we can furnish the top-quality power package you want.



Gearmotor for agitator drive on bulk milk cooler. Stainless steel shaft. Leak-proof seal.

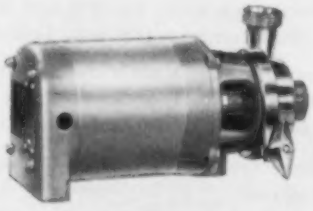


Special diameter motor parts for use in rotary oil burners. Range ½ to 5 HP.

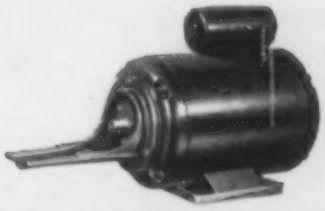


Floor machine motor. Low contour—high torques—pleasing appearance.

Doerr motor with special mounting used on leading 10" tilting arbor saw.



Sanitary dairy pump motor . . . Doerr-Designed to customer's specifications.



Special pump bracket eliminates mounting and alignment problems. Saves space and weight.

Special and standard electric motors from 1/30 to 5 HP that exactly meet your needs.

You Get MORE with Doerr!

Write for New Bulletin on Electric Motors Without Obligation

DOERR
Electric Corporation
CEDARBURG, WISCONSIN

NEW *Ambi-stat*

temperature controller could be just what your product needs

It's ambient-compensated... compact... economical

Been looking for a temperature controller . . . in the low-cost bracket . . . that won't be bothered by changes in ambient temperature?

Here it is—the new Honeywell *Ambi-stat*. It's the ideal way to control temperatures in such equipment as bulk milk tanks, dry cleaning washers, vending machines, dishwashers, chicken scalders. It makes a highly dependable alarm . . . for high temperatures, or for frost.

New dependability. For the first time in a low-priced control, you get accurate control action regardless of ambient temperatures.

New versatility. Models are available for either heating or cooling applications . . . single or double-throw switching . . . temperatures 0—70 F or 40—180 F . . . nominal differential 2 F or 5 F.

Snap-action switching assures precise, sharp control at the set point. The small bulb . . . $\frac{3}{8}$" in diameter by $3\frac{1}{8}$" long . . . fits readily into your own product design. The complete controller is small, compact, easily mounted on practically any equipment.

REFERENCE DATA:
Write for Specification Sheet No. 868, "Honeywell *Ambi-stat* Remote Bulb Temperature Controllers."

Get complete data, consultation on application, and prices from your local Honeywell sales engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

H HONEYWELL

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

ends of the conductors are inserted in the openings of the switch housing and are automatically locked in place. Two, three, or four positions are available in a single-size case measuring 1¼ x 1¼ x 8⅞ in.

The new switch is UL-approved at a rating of 6 amp, 125 v, ac only. General Electric Co., Bridgeport 2, Conn.

For more information—
Circle 80, inside back cover

Pneumatic Switching Valve

A pneumatically operated valve for use with dual pressure pneumatic control systems has been announced. This exhausting three-way valve will switch automatically on a dual supply pressure change, eliminating the need for a separate air line from a central station to accomplish the switching. The three pipe connections are normally open, normally closed and common. Johnson Service Co., Milwaukee 1, Wis.

For more information—
Circle 81, inside back cover

Hydraulic Symbols Template

This template has cut-outs that depict JIC industrial hydraulic symbols for designing circuits. Made of 0.030 in. matte finish plastic. All cut-outs are milled. Actual size of the template is 7 x 4½ in. Rapidesign, Inc., Box 592, Glendale, Calif.

For more information—
Circle 82, inside back cover

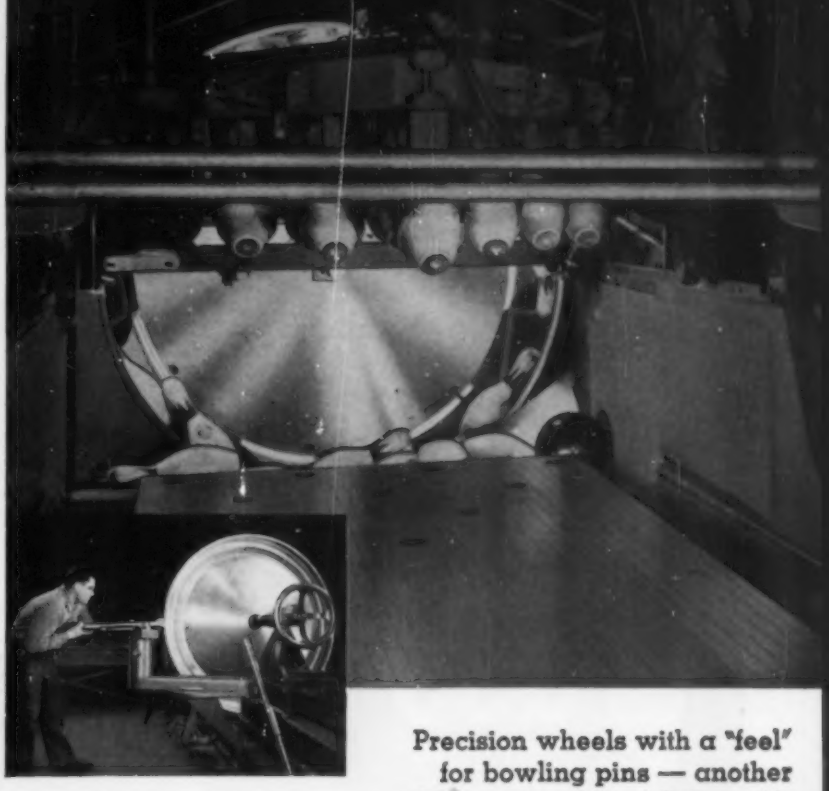
A-c Line Regulator

This tubeless regulator contains no moving parts or vibrating contacts. Input voltage range is 95 to 135 v and

(Continued on page 298)

Spincraft did it for AMF . . .

Spincraft can do it for you!



NINE DIFFERENT OPERATIONS—
Spinning and forming tolerances to .031"

On each 5-ft. wheel, Spincraft assumed 100% fabricating responsibility: deep draw, spin, punch, blank, stamp and form, pantograph (chamfer), surface finish, drill, rivet, carton and ship. Operator (above) is spinning the ⅛-in. thick sheet of tough 52S aluminum alloy. Cross-section of basic wheel (right) shows unusual contour requirements. Raised segments are ⅛-in. cold rolled steel.

Write for Spincraft data book. If you have a specific problem, tell us about it — no obligation.

Precision wheels with a "feel" for bowling pins — another example of Spincraft's fabricating skill

By setting pins faster, American Machine and Foundry's automatic pin spotter gives more bowlers more opportunities for better scores! Spincraft is proud to have successfully fabricated a key component of the AMF pin spotter. It's the large-diameter pin elevator wheel — our solution to a difficult production problem for this well-known manufacturer.

This is *one more* example of Spincraft's versatility, capacity and skill. We offer complete facilities for contract manufacture of metal parts or complete units. No jobs are too big — or too small. One piece or millions are taken in stride.

Engage the facilities of the world's largest metal spinning plant — the only such plant also equipped for deep drawing, stamping and complete fabrication. You'll get results and savings that far exceed your expectations!

SERVING INDUSTRY SINCE 1919 . . .

World's largest plant fully equipped for all types of metal spinning • deep drawing • stamping • fabricating

Spincraft
SKILL WILL DO IT
INCORPORATED

4124 WEST STATE STREET • MILWAUKEE 8, WISCONSIN

Type 500 Goodman Continuous Coal Mining Machine in operation.

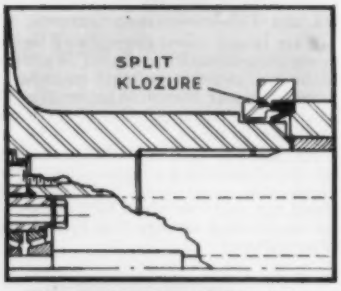
Garlock Split-KLOZURE Oil Seal—specifically designed for heavy equipment.

Goodman Mining Machines get positive bearing protection with KLOZURE* OIL SEALS!

The bearings on Goodman Mining Machines are subjected to the most severe service conditions—particularly coal dust and dampness. To provide positive protection for these costly bearings, Goodman engineers use dependable KLOZURE Oil Seals.

Garlock Split-KLOZURES, which can be installed around the shaft *without* dismantling the equipment, are used on the main bearing. Standard Model 53 Finger Spring KLOZURES (not illustrated) are used on the tractor roller bearings.

Let us show you how superior KLOZURE Oil Seals can solve your sealing problems. Just contact the Garlock office nearest you, or write for KLOZURE Catalog 10.



Cross section shows Garlock Split KLOZURE Seal as applied to the rotor assembly (main) bearing of Goodman's Type 401 Miner.

*Registered Trademark

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

Sales Offices and Warehouses: Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, Los Angeles, New Orleans, New York City, Palmyra (N.Y.), Philadelphia, Pittsburgh, Portland (Oregon), Salt Lake City, San Francisco, St. Louis, Seattle, Spokane, Tulsa.

In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

GARLOCK

the "inside" story!

SILICON STEEL LAMINATIONS—give high efficiency.
HARDENED BERYLLIUM COPPER PLUNGER GUIDE — reduces friction and wear.
SHOCK-ABSORBING BUMPERS — reduce self-destruction, cushion stroke, assure longer service.
HEAVY SILICONE INSULATED MAGNET WIRE — wound on high flow point molded nylon bobbin.
TEMPERED STEEL SPRING — absorbs vibration — holds assembly firmly in alignment.

HORIZONTAL PUSH-TYPE WELDED BASE

VERTICAL PULL TYPE SHOCK-MOUNTED

VERTICAL PUSH-TYPE WELDED BASE

AC WAFER SOLENOID

FOR COMPLETE INFORMATION ON ALL DECCO INDUSTRIAL SOLENOIDS WRITE:

DC INDUSTRIAL SOLENOID

of dependable

Decco

INDUSTRIAL SOLENOIDS

In addition to all the "inside" advantages, Decco Solenoids are compactly designed and thoroughly impregnated with silicone baking varnish for high moisture resistance.

Decco Solenoids are made in all types, sizes and shapes. SPECIAL SOLENOIDS ENGINEERED TO YOUR PROBLEMS.

Decco SOLENOIDS THE HEART OF DEPENDABLE AUTOMATION EQUIPMENT

DETROIT COIL COMPANY

2435 HILTON ROAD, FERNDALE 20, MICHIGAN

we work with Fluorocarbons ...and "know-how"

Electronics Test Cage

Physical Testing Laboratory

Injection Molding

Fluorocarbon Machining

The United States Gasket Company is the recognized leader in the fabrication and application of the "Wonder Plastics", duPont TEFLON, Kellogg KEL-F and BAKELITE Fluorothene—leadership earned through many years of pioneering.

Today, this company offers engineering and manufacturing talent and facilities unmatched in the industry to assist its customers in the profitable application of Fluorocarbon Products for almost countless purposes.

To render this service, three highly specialized laboratories are maintained—electronic, chemical and physical—staffed by engineers who continue to produce most of the advanced ideas and practices in the application of these plastics to commercial, A.E.C. and military requirements.

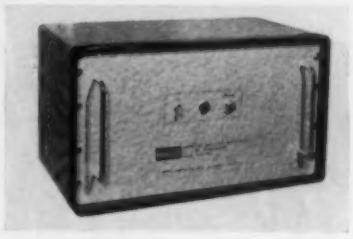
Manufacture is Quality Controlled, utilizing the most modern facilities for rapid, low cost production. Many machines and equipment have been designed or converted by our own engineering department to the peculiar requirements of Fluorocarbon Plastic Fabrication.

• Write for the twenty-page brochure "Inside U. S. G." that suggests how this organization can fit into your development and production program.

U S G BELMONT

UNITED STATES GASKET CO.

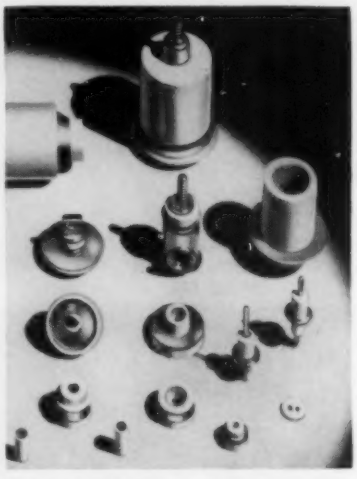
CAMDEN 1, NEW JERSEY



output voltage is a nominal 115 v (can be adjusted from 110 to 120 v).

Regulation accuracy is ±0.25 per cent for any combination of line or load. Maximum load is 1.0. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

For more information—
Circle 83, inside back cover



Metalized Hermetic Terminals

These terminals may be installed by silver soldering at temperatures up to 1382 F. Copper-brazed terminals are also available for still higher temperature applications. American Lava Corp., Cherokee Blvd. and Manufacturers Road, Chattanooga 5, Tenn.

For more information—
Circle 84, inside back cover

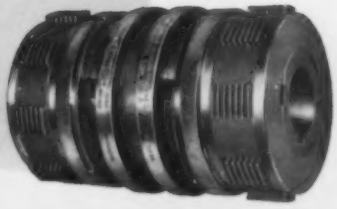
Drafting Desk

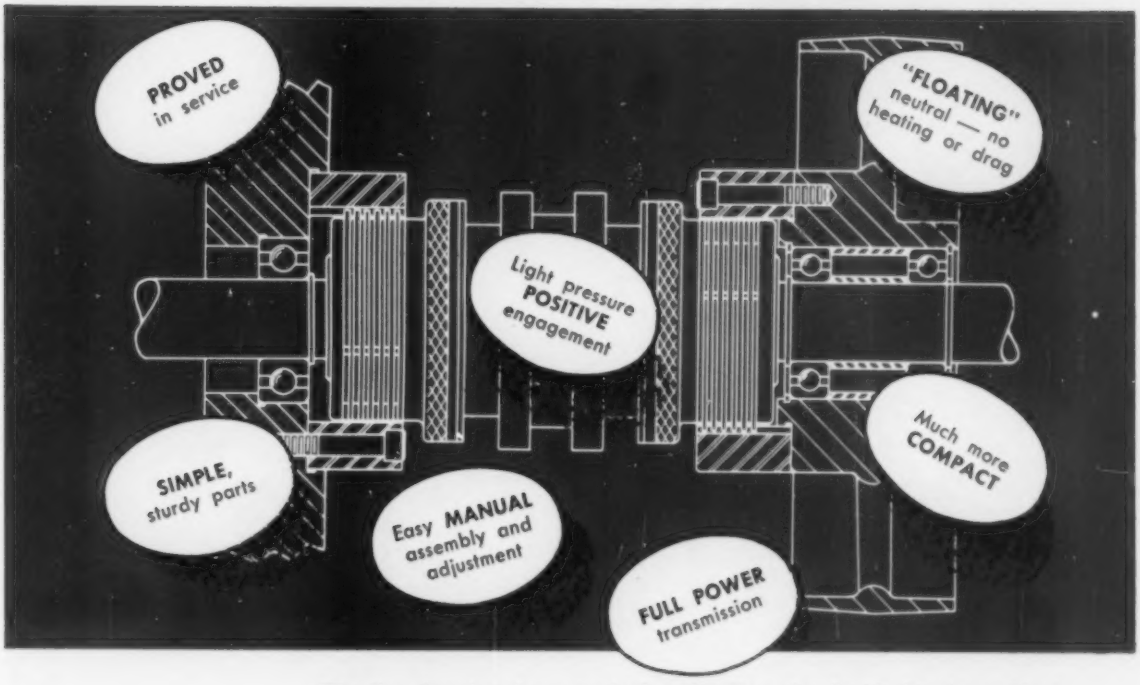
This line of drafting desks is built around fourteen basic models, which can be put together and interchanged for efficient and economical work planning. The desk-high steel units have plastic and linoleum work surfaces and

(Continued on page 302)

ASSURE YOUR PRODUCT THE *PROVED* SUPERIORITY OF A

MAXITORQ *floating disc* CLUTCH

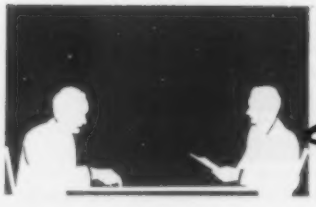



PROVED in service
"FLOATING" neutral — no heating or drag
Light pressure POSITIVE engagement
SIMPLE, sturdy parts
Much more COMPACT
Easy MANUAL assembly and adjustment
FULL POWER transmission

The line drawing shows typical application of a double Maxitorq Floating Disc Clutch, arranged for both drive and brake, with ring-type driving cups.

Such installations have a well-proved record of efficiency and freedom from maintenance. Drive and brake engagement and disengagement are smooth and positive . . . without drag or heating . . . because exclusive MAXITORQ design assures that discs ride free in neutral.

MAXITORQ Floating Disc Clutches are available in a wide range of sizes and types . . . single, double, overload release . . . to meet specific installation demands. Our engineering department also stands ready to help you solve special drive problems. Write or phone Dept. PE-1. The Carlyle Johnson Machine Company, Manchester, Conn.



Let's talk **MAXITORQ**

6CJ88

NEW versatile STOKES powder metal press

A new 50-ton multiple-motion press offers increased economy to powder metal molders

Here is a powder metal press so new, so radically different from anything in the field today that it presents entirely new possibilities for efficient industrial compacting. With its simplified tooling and fast operation, the 640 press outdates all other designs; makes possible the application of powder metal to the production of parts for which the process has never before been considered economical.

The Stokes Model 640 is a completely new design, based on an intimate knowledge of the industry's requirements. It represents the latest achievement in Stokes 35-year experience in the design and manufacture of presses specifically for powder metallurgy.

For example, the 640 press is the first to give full, *50-ton simultaneous breakaway* on multiple lower punches, important in successful ejection of complex parts; *centralized controls*, for easy, fast set-up and operation; *independent adjustments* of all press actions while the machine is running; *direct-reading handwheel calibrations*, that eliminate guess-work on settings, permit exact records for each piece produced.

If you are now compacting powdered metals or are investigating how this economical process can be applied to your production, you should know about the many exclusive features of the Stokes Model 640 press. Write for Bulletin 670.

F. J. Stokes Machine Company
Philadelphia 20, Pa.

The pieces shown are typical of parts for which the Model 640 press is particularly well suited. Difficult parts like these and pieces with double hubs, multiple levels and thin flanges all can now be made economically on the Stokes Model 640 press.

STOKES

OFFICES IN PRINCIPAL CITIES,
REPRESENTATIVES THROUGHOUT THE WORLD

Here's the story...

ON Century's NEW SMALLER, BETTER MOTORS 1 TO 30 H.P.

In this revealing book, Century shows how and why the *New Standard*, smaller motors actually outperform the larger, heavier Old Standard models.

These trim, compact "*New Standards*" give you weight savings up to 40% . . . plus space savings and easier installation. Dead weight and dead air space are eliminated. The "active materials," such as iron and copper, are designed to give greater efficiency than ever before. New synthetic insulating materials give greater dielectric strength and uniformity.

SEND FOR YOUR *PERSONAL* COPY OF THIS VALUABLE DATA BOOK . . . !

Mail this coupon today!

To CENTURY ELECTRIC COMPANY
1806 Pine Street, St. Louis 3, Mo.

Please send New Bulletin 6-1P1 to:

Name..... Title.....

Company.....

Address.....

City..... Zone..... State.....

Performance Rated©
MOTORS
1/20 to 400 H.P.

CENTURY ELECTRIC COMPANY

45

1806 Pine Street • St. Louis 3, Missouri • *Offices and Stock Points in Principal Cities*

a tight seal... for a hot spot | with PRESSTITE

HIGH TEMPERATURE SEALER #589

When an automatic clothes washer swings into action, plenty of hot, cleansing water gets dashed around. But the washer's outer shell seams are well protected against hot water splash-over and the corrosive action of detergents when they're sealed with Presstite's #589 high temperature sealer. Once applied, this sealer really stays in place.

Prolonged temperatures as high as 250°F. won't cause the sealer to expand or harden. It always stays soft and plastic, maintaining its excellent adhesion. Wherever operating temperatures are high, you can count on this Presstite compound to seal tight. Furnished in beads, tapes or bulk.

Since 1924, Presstite has developed and produced hundreds of sealants to give you the best answers for sealing problems in the design field. It will pay you to consult a sealing specialist. Write Today.

PRESSTITE SEALING COMPOUNDS

In Canada:
RAILWAY and POWER ENGINEERING CORP., LTD.

PRESSTITE ENGINEERING COMPANY

lightweight aluminum drafting boards. All components will fit together and can be assembled into practically any office layout desired.

Drawing-board sizes range from 26 by 40 in. up to 43¼ by 72 in. The drawing board is constructed of two 0.035-in. aluminum sheets bonded to a honeycomb cellular core. The linoleum top surface offers exactly the right "tooth" for all grades of drawing pencils or inking. The board is reported to weigh one-third the weight of a wooden board of the same volume and is not subject to atmospheric or climatic changes.

Drawing board is mounted on nylon rollers and is counterbalanced for vertical height adjustment up to 12 in., permitting the draftsman to sit or stand with equal convenience. Board may also be adjusted to any angle from 10 deg off vertical to 10 deg from horizontal and can be locked at the selected angle by quick-action cam lever. Emeco Corp., Hanover, Pa.

For more information—
Circle 85, inside back cover

Oscillograph Record Camera

High-resolution film images without distortion regardless of aperture setting are featured in a continuous-motion oscillograph record camera, intended for making moving film or single-frame recordings of patterns on cathode-ray oscillograph screens. The Type 321-A employs an f/1.5, 50 mm, six-element Wollensak lens.

The new camera uses a friction film drive, as opposed to sprocket drive, which results in easier threading of procedures, freedom from jamming or torn films, and complete freedom from film-speed variations because of shrinkage. The friction drive also permits use of recording papers instead of film. Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.

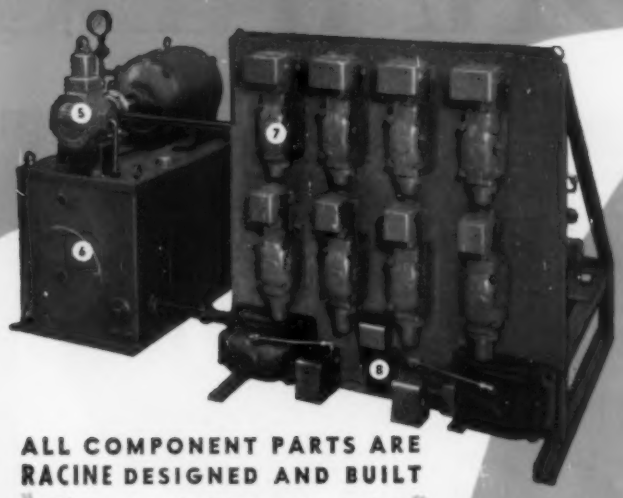
For more information—
Circle 86, inside back cover

Self-Measuring Dividers

It is possible to set this instrument's divider for any fractional dividing space up to 1 in., by simply setting the movable arm of the divider. Once it is

(Continued on page 306)

A Compact Hydraulic POWER HOUSE
one of many built by Racine for you . . .



ALL COMPONENT PARTS ARE
RACINE DESIGNED AND BUILT
"They work better together"

RACINE
Variable Volume
OIL HYDRAULIC PUMPS

1. RACINE Pilot Operated Check Valves
2. RACINE Free Flow and Throttling Check Valves
3. RACINE Pressure Boosters
4. RACINE Sequence Valve
5. RACINE Variable Volume Pump
6. RACINE Oil Reservoir
7. RACINE Solenoid Controlled, Pilot Operated 4-way Valve
8. RACINE Solenoid Operated 2-way Valve

SALES AND SERVICE REPRESENTATIVES
IN ALL PRINCIPAL CITIES.

Racine Hydraulic Components Simplify any Hydraulic Circuit — "They Work Better Together." Write for complete Racine Hydraulic Catalog and the name of your nearest Racine Field Office. Complete Engineering Service Available. Address: **RACINE HYDRAULICS & MACHINERY, INC.,** 2072 Albert St., Racine, Wisconsin, U.S.A.

TDA® BRAKES

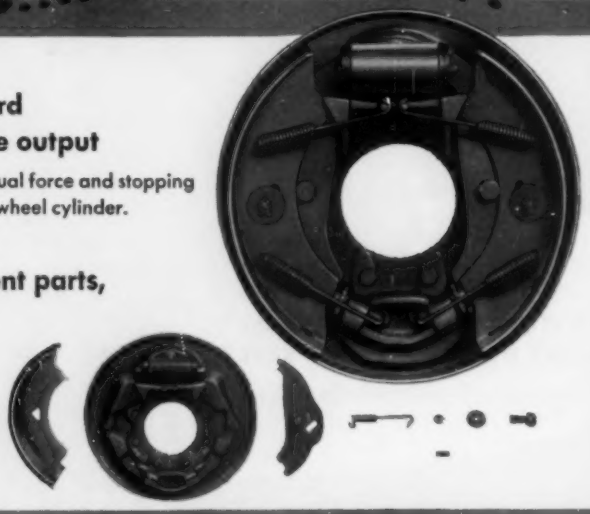
if it moves...we can stop it!

equal forward and reverse torque output

Both shoes are applied evenly with equal force and stopping action through a single, straight bore wheel cylinder.

only 8 different parts,

exclusive of wheel cylinder, the superior "DH" brake design reduces parts inventory and simplifies maintenance . . . actually 40% fewer parts than most competitive designs.



"DH" DUPLEX HYDRAULIC BALANCED BRAKE

designed for heavy-duty service

Greater safety, immediate response, less maintenance and easier servicing are all a part of this rugged new hydraulic brake.

Highly efficient, the "DH" brake is basically a self-energizing two-shoe brake in which both shoes do an equal share of the work . . . and are applied to the brake drum with equal effectiveness in both forward and reverse directions. Floating shoe design eliminates heel and toe clearance problems.

Far simpler, the "DH" brake has actually 40% fewer parts than most competitive designs. This results in smaller parts inventory and easier servicing.

The "DH" brake has already met overwhelming acceptance from many leading manufacturers and operators. Efficiency and design advantages are winning new uses for the "DH" brake every day.

"DH" Series Hydraulic Brakes are available in a broad range of capacities and sizes . . . to meet a variety of operating needs.

For additional information . . . with expert consultation, contact the Timken-Detroit® Brake Division. Complete details and specifications on the "DH" brake are available. A staff of experienced engineers is ready to assist you with any brake problem you may encounter.

©1956 R S & A Company

For every industrial, agricultural or automotive application where braking is required!

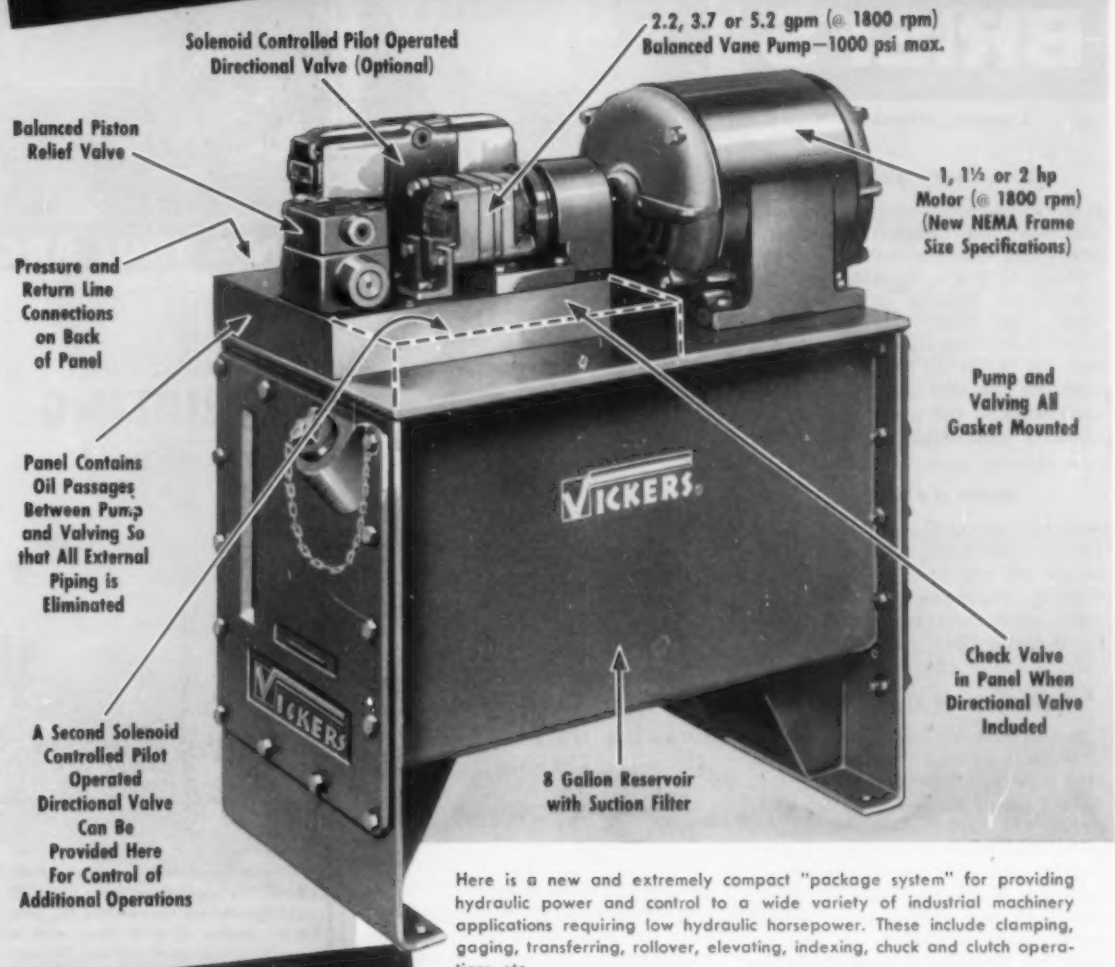
Plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York Ashtabula, Kenton and Newark, Ohio • New Castle, Pennsylvania

TIMKEN Detroit BRAKES

TIMKEN-DETROIT BRAKE DIVISION ROCKWELL SPRING AND AXLE COMPANY

Accepted TDA Standard

A NEW IDEA . . . in hydraulic power and control systems


Solenoid Controlled Pilot Operated Directional Valve (Optional)
2.2, 3.7 or 5.2 gpm (@ 1800 rpm) Balanced Vane Pump—1000 psi max.
Balanced Piston Relief Valve
1, 1½ or 2 hp Motor (@ 1800 rpm) (New NEMA Frame Size Specifications)
Pressure and Return Line Connections on Back of Panel
Pump and Valving All Gasket Mounted
Panel Contains Oil Passages Between Pump and Valving So that All External Piping is Eliminated
VICKERS
Check Valve in Panel When Directional Valve Included
A Second Solenoid Controlled Pilot Operated Directional Valve Can Be Provided Here For Control of Additional Operations
8 Gallon Reservoir with Suction Filter

Here is a new and extremely compact "package system" for providing hydraulic power and control to a wide variety of industrial machinery applications requiring low hydraulic horsepower. These include clamping, gaging, transferring, rollover, elevating, indexing, chuck and clutch operations, etc.

Note the many features indicated on the photograph above. The result is improved and simplified hydraulic design . . . also reduced installation and maintenance costs. This "package system" has great flexibility . . . is available in a wide variety of combinations of standard components assembled to suit individual requirements. Pretested and ready for immediate operation, it has also the advantage of undivided Vickers responsibility. For further information, ask for installation drawings 178706-8.

VICKERS®

Series T8 HYDRAULIC PIPELESS POWER PACKAGE*

VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION

1454 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices: • ATLANTA • CHICAGO • CINCINNATI CLEVELAND • DETROIT • HOUSTON • LOS ANGELES AREA (El Segundo) MINNEAPOLIS • NEW YORK AREA (Summit, N.J.) • PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) • PORTLAND, ORE. • ROCHESTER ROCKFORD • SAN FRANCISCO AREA (Berkeley) • SEATTLE • ST. LOUIS • TULSA WASHINGTON • WORCESTER

IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto

7311

*These "package systems" supplement the Vickers line of standard hydraulic power units.

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

COOPER ALLOY
CORPORATION
BRIEFS

• Edited by GEORGE BLACK

AKH #3 NOW AVAILABLE

How to maintain close dimensional accuracy, fine interior and exterior finish and uniform soundness in the casting of a 1¼ lb. stainless steel instrument housing is told in the latest case history in the Cooper Alloy Advanced Know-How series. Ask for AKH #3 and get the full story on the use of shell mold and shell cores in the production of one of those "impossible" castings.

BUNA N FITTINGS

Vanton's line of Buna N and natural hard rubber fittings is described in a newly revised four-page condensed catalog. Diagrams, dimensions, and application data are included. Ask for Bulletin BN.

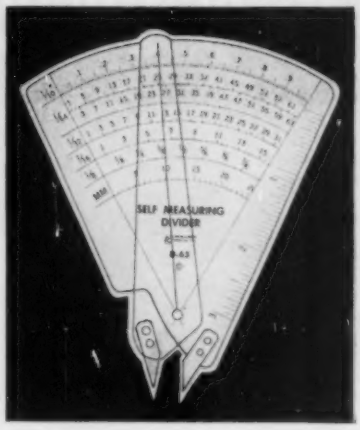
INQUIRIES AT ALL TIME HIGH

The demand for technical literature of value is on the increase. Our librarian reports more than 20,000 individual pieces of literature requested during the past twelve months, and we're glad to know that we are serving the needs of so many plant operating and purchasing people. For a quick glance at the most recent publications available on request, write for Technical Literature Folder TL56.

OUR FACE IS STILL RED

We're still apologizing to the many people who have requested our deluxe stainless steel valve and fitting catalog. The demand not only exceeded our supply but our ability to process them as well. Even with daily overtime and Saturday work we still haven't caught up with requests . . . so please forgive us if you're one of those on the waiting line.

COOPER ALLOY
CORPORATION • HILLSIDE, N.J.



set, as many similar spaces as desired may be marked off very rapidly, using the pointed ends successively.

The dividing spaces can be set on any one of six visible scales. The scales are marked for tenths, sixty-fourths, thirty-seconds, eighths of an inch and millimeters. There is a 3 in. ruler on the side of the divider. The divider is of transparent plastic. C-Thru Ruler Co., 827 Windsor St., Hartford, Conn.

For more information—
Circle 87, inside back cover

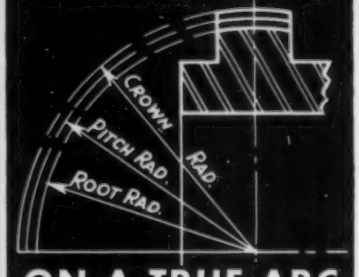
Drawing Board T-Square Combination

To make angular drawings with this combination drawing board – T-square, determine the proper angle desired and set indicator on protractor at the proper degree. If 90 deg angle is desired, set T-square indicator at right angles and let it lock into position.

The drawing board used in this new unit is made of Finnish white birch, and board is covered with replaceable high-grade covering of moisture-resistant, laminated paper. Guide rails are of tempered aluminum and are on three sides of the board. T-square is handmade. It is constructed of Honduras mahogany. Blade is white maple with clear lucite edge, dovetailed and bonded. Wing nut never needs adjusting. Legs are cushioned with rubber to protect desk. This drawing board-T-square combination is made for 24x32 in. and larger size boards. Weller Engineering Co., 169 La Verne Ave., Long Beach 3, Calif.

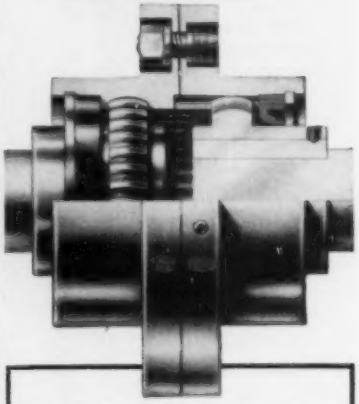
For more information—
Circle 88, inside back cover

Here's the Big
DIFFERENCE
TEETH ARE CUT



ON A TRUE ARC

SPHEREFLEX®
COUPLING



SPHEREFLEX tooth design features an exclusive curved root and spherical tooth flank. Both angular and linear (parallel) misalignment are compensated for, since every portion of each gear tooth is actually a segment of a sphere. This special design eliminates all possibility of tooth interference and permits increased deflection between mating members. Full and uniform line contact, through the working depth of the tooth, insures a stronger coupling between driver and driven shafts; eliminates point rolling contact between gears during flexing; compensates for shaft misalignment up to 14° included angle. Send for Catalog C-560

PHILADELPHIA GEAR WORKS
INCORPORATED
ERIE AVE. AND G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.
BALTIMORE • CLEVELAND
Virginia Gear & Machine Corp., Lynchburg, Va.
Industrial Gears & Speed Reducers • LimiTorque Valve Controls
Established 1892

Unsinkable 42-pound Dylite* plastic float supports 20 times its own weight!

The 36" diameter plastic float was made in halves by placing a quantity of DYLITE beads in a mold (a section of the mold is shown to the right) and applying heat. The tiny plastic beads expanded to fill the entire mold with a strong, lightweight sphere.

The Navy needed a tough, lightweight float to support equipment weighing over 800 pounds. Additional requirements: the float must withstand a fall into the ocean, be easy to fabricate and float indefinitely.

After careful consideration, Navy scientists chose DYLITE expandable polystyrene for the float.

DYLITE, the new foamed plastic introduced 18 months ago by Koppers, has found many unusual applications. Tests have shown this extremely lightweight material ideal as a buoyancy agent. It is strong, waterproof, resilient, easy to mold into any shape required, is virtually unsinkable and low in cost.

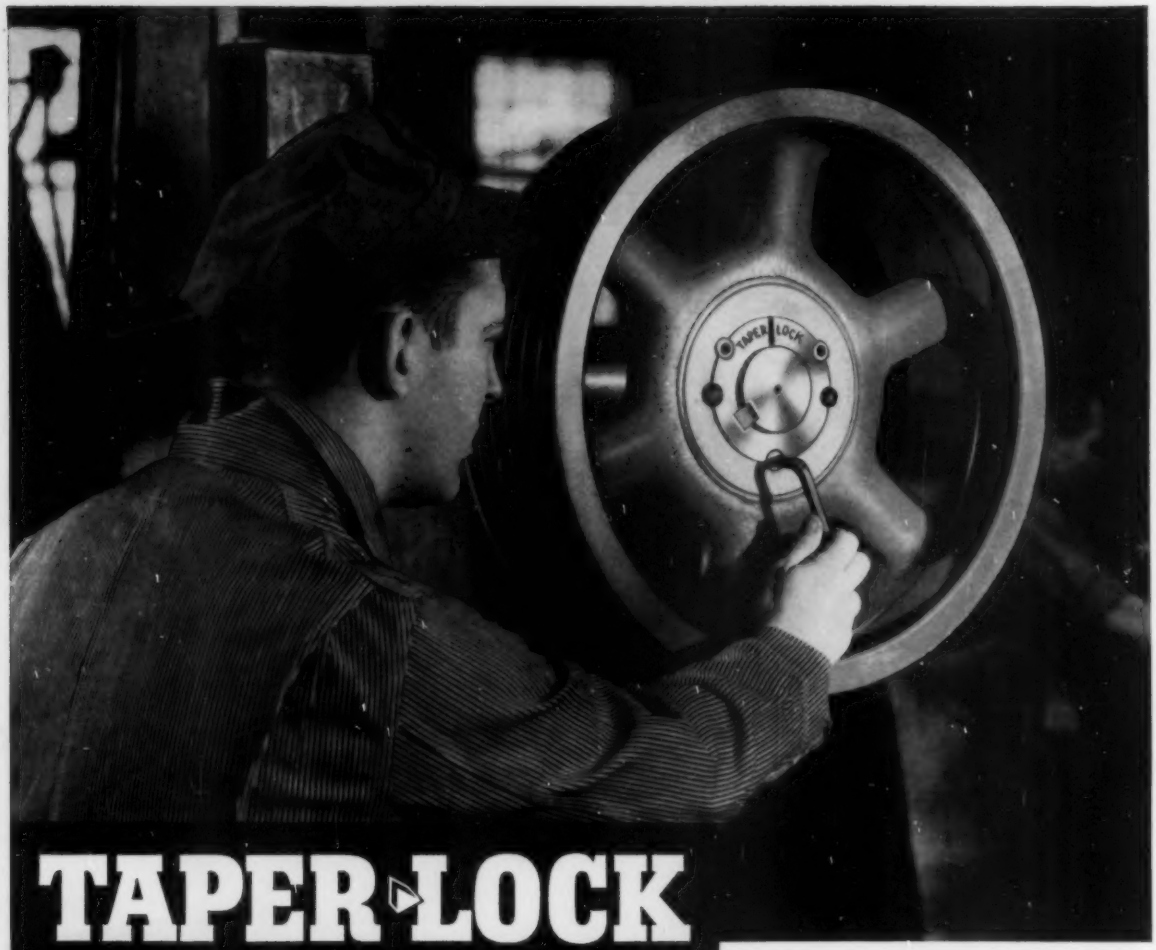
For more information write to the Koppers Company, Inc., Chemical Division, Dept. PE-16, Pittsburgh 19, Pennsylvania. *Koppers Trademark*

KOPPERS

KOPPERS PLASTICS

SALES OFFICES: New York · Boston · Philadelphia · Atlanta · Chicago · Detroit · Houston · Los Angeles

In Canada: Dominion Anilines and Chemicals Ltd., Toronto, Ontario



TAPER-LOCK

A PATENTED PRODUCT OF DODGE

The simplest, surest means of mounting wheels to shafts!

Slip it on the shaft, line it up and tighten while sighting! Mount sheaves, sprockets, couplings, conveyor pulleys *quicker*—and more easily—with Taper-Lock bushings. A few twists of a hex wrench and Taper-Lock grips the shaft with the firmness of a shrunk-on fit. It comes off as easily, without shock to bearings or machinery. Bushing seats evenly along entire length of the hub—*wheels run true!*

Standardize on Taper-Lock. You save time and money and keep production rolling with these *interchangeable* bushings. See your Dodge Distributor, or write us for the full Taper-Lock story.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone directory, or write us.

THERE'S ONLY ONE TAPER-LOCK, THE BUSHING THAT MOUNTS FLUSH!

Standardize, economize with Taper-Lock, the bushing that is interchangeable in Dodge sheaves, sprockets, couplings and conveyor pulleys. *More than 2,000,000 in use!*

DODGE

of Mishawaka, Ind.

DODGE MANUFACTURING CORPORATION, 1200 UNION STREET, MISHAWAKA, INDIANA

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 325.

Electrical - Electronic Components–Catalog B4, 63 pp, describes connectors, cables, other components. American Phenolic Corp., 1830 S. 54 Ave., Chicago 50, Ill.

Circle 89, inside back cover

Double-Enveloping Gears–Bulletin CA-55, 12 pp, gives engineering details on the assembly procedure for double-enveloping worm gearing. Cone-Drive Gears Div., Michigan Tool Co., 7171 E. McNichols Road, Detroit 12, Mich.

Circle 90, inside back cover

Speed Control–Bulletin 4400-PRD-229, 4 pp, explains use of magnetic amplifier speed control for both fan-type and constant torque loads. Electric Machinery Mfg. Co., Minneapolis 13, Minn.

Circle 91, inside back cover

Deposited Carbon Resistors–Bulletin 100, 2 pp, gives resistance values, specification data on both axial lead and radial lead resistors. Electroseal Products, Inc., 22 E. 40 St., New York 16, N. Y.

Circle 92, inside back cover

Powder Metallurgy Standards–Data sheet 4, 4 pp, lists and correlates all of the commercially available standards, specifications and other references on metal powders and metal powder products. Metal Powder Assn., 420 Lexington Ave., New York 17, N. Y.

Circle 93, inside back cover

Cast Irons–Bulletin, 20 pp, provides specifications for six classes of metallurgically controlled irons. McNally Pittsburg Foundries, Inc., Pittsburg, Kan.

Circle 94, inside back cover

Stainless Brazing Paste–Data sheet 12, 3 pp, describes composition and properties as well as outlining some recommended applications. Application procedure is also explained as well as methods for removing flux and separating joints. Wall Colmonoy Corp., 19345 John R St., Detroit 3, Mich.

Circle 95, inside back cover

Asbestos and Other Products–Handbook, 52 pp, describes insulation and refractory products, asbestos-cement pipe; packings and gaskets; electrical products; filters and fillers, silicates, friction materials. Johns-Manville, 22 E. 40 St., New York 16, N. Y.

Circle 96, inside back cover

Speed Control and Drive–Bulletin 1500, 8 pp, describes drive consisting of electronic control unit and d-c motors. Louis Allis Co., Milwaukee 7, Wis.

Circle 97, inside back cover

Alloy for Anchoring Machine Components–Bulletin, 4 pp, describes a low-melting point bismuth-tin-lead alloy used for anchoring bearings, bushings, and non-moving parts in machine tools and other heavy equipment. Cerro de Pasco Corp., 300 Park Ave., New York 22, N. Y.

Circle 98, inside back cover

Brass Alloy Powders–Bulletin, 2 pp, lists chemical composition of each alloy and provides properties and characteristics. Dixon Sintaloy, Inc., 535 Hope St., Stamford, Conn.

Circle 99, inside back cover

Bismuth Alloys–Bulletin, 4 pp, gives data and applications on low-melting point alloys used for anchoring, soldering, molding, patterns. Cerro de Pasco Corp., 300 Park Ave., New York 22, N. Y.

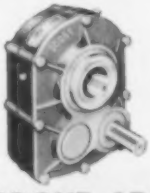
Circle 100, inside back cover

Carbon and Alloy Steels–Chart shows approximate relation between hardness by various testing systems and tensile strength of steels. Hardness systems covered are Brinell, Monotron,

(Continued on page 310)

DODGE PRODUCTS you should know

FLEXIDYNE
DRIVES & COUPLINGS



TORQUE-ARM
SPEED REDUCERS

DODGE-TIMKEN
PILLOW BLOCKS

DODGE BULLETINS YOU SHOULD HAVE

- Flexidyne Dry Fluid Drives and Couplings. Complete story and selection data. Bulletin A-640-A.
- Torque-Arm Speed Reducers. Technical data and selection methods on all 14 sizes—1 to 60 hp. Bulletin A-637.
- Rolling Bearings. Load ratings, dimensions and other data on Dodge-Timken and SC and SCM Ball Bearings. Bulletin A-638.

Write for your copies.

DODGE MANUFACTURING CORPORATION
1200 Union Street • Mishawaka, Indiana

DODGE
of Mishawaka, Ind.

Mr. Design Engineer:
Durakool is the STANDARD
OF QUALITY, DURABILITY AND LIFE
Durakool pressurized all-steel mercury tilt switches have more than made good on what may have seemed like extravagant claims a few years ago. The list of Durakool successes grows each year. Seven sizes, 1 to 65 amperes. 3 to 4 weeks delivery. Your production schedule is met.
Send for BULLETIN 525
Steel Durakool
MERCURY SWITCHES
See telephone directory for local distributor, or write.
DURAKOOL, INC.
ELKHART, INDIANA, U.S.A. • 700 WESTON RD., TORONTO, CANADA

Vickers and Rockwell (B, C and E scales). Babcock and Wilcox, Beaver Falls, Pa.

Circle 101, inside back cover

Metallizing—Bulletin 120, 6 pp, illustrates and describes applications of metallizing in the production of electrical and electronic eqiupment. Also provides engineering data on bond strength, conductivity characteristics, permissible coating thicknesses, circuit tests, surface preparation and spraying methods. Metallizing Engineering Co., Inc., 1101 Prospect Ave., Westbury, N. Y.

Circle 102, inside back cover

Seamless and Welded Tubing—Bulletin TB 408, 7 pp, contains listing of types of tubing produced and a brief description of various kinds of technical literature available on such specific types of tubular products as stainless and alloy tubing, stainless pipe, stainless sanitary tubing, heat exchanger and condenser tubing, boiler tubing and mechanical tubing. Babcock & Wilcox, Beaver Falls, Pa.

Circle 103, inside back cover

Investment Casting—Booklet, 24 pp, discusses castability and its effect on alloy selection for the investment casting process. Engineered Precision Casting Co., Box 68, Matawan, N. J.

Circle 104, inside back cover

Colloidal Dispersions—Booklet, 4 pp, lists 42 colloidal and semi-colloidal dispersions for operational functions, maintenance, lubrication, machine design and other industrial applications. Acheson Colloids Co., Port Huron, Mich.

Circle 105, inside back cover

Fluid Motors—Booklet, 8 pp, describes motor which converts oil under pressure to rotary motion. Sundstrand Machine Tool Co., Rockford, Ill.

Circle 106, inside back cover

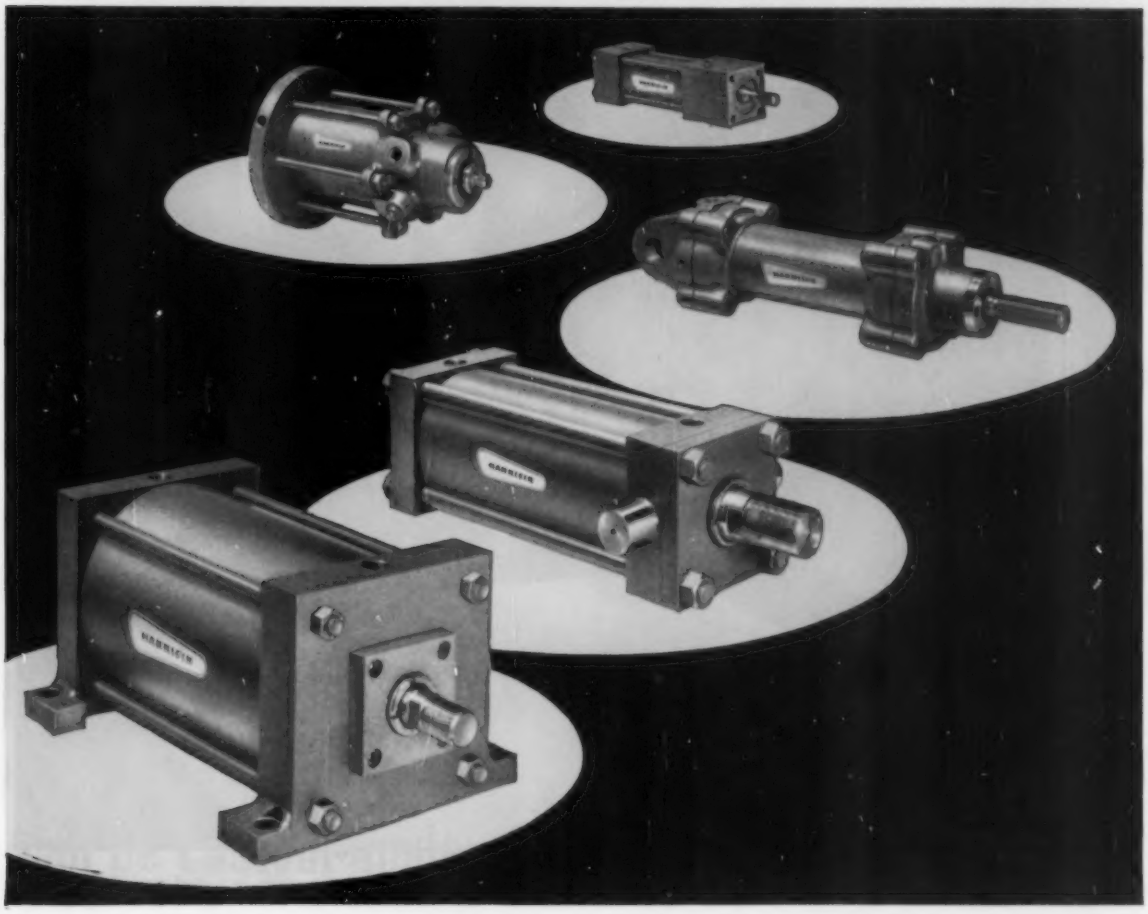
Glass-bonded Mica—Handbook and catalog, 23 pp, describes this electrical insulating material, its properties and available forms. Mycalex Corp. of America, Clifton Blvd., Clifton, N. J.

Circle 107, inside back cover

Electric Motors—Catalog 106, 29 pp, contains information on a-c motors.

(Continued on page 314)

HANNIFIN AIR AND HYDRAULIC CYLINDERS



To the engineer who wants the best cylinder—in a hurry

In the selection and purchase of cylinders look for:

Completeness of Line. Hannifin makes *five* lines of air and hydraulic cylinders in a range of bore sizes and mounting styles to meet every requirement and preference.

Leadership in Design. Hannifin cylinders are built to exacting quality standards and extremely close tolerances to insure easy, accurate mounting. Hannifin has also introduced the *externally removable* and replaceable bronze gland cartridge, the most noteworthy improvement in cylinder design in the last 50 years.

Rapid Delivery. Hannifin can ship the cylinder you need in strokes up to 60" *in any normal quantity within 48 hours.*

Field Engineers, located in all principal cities, are as near as your telephone. Or, if your requirements are really urgent, call us at Des Plaines. Experienced sales engineers will handle your order.

HANNIFIN

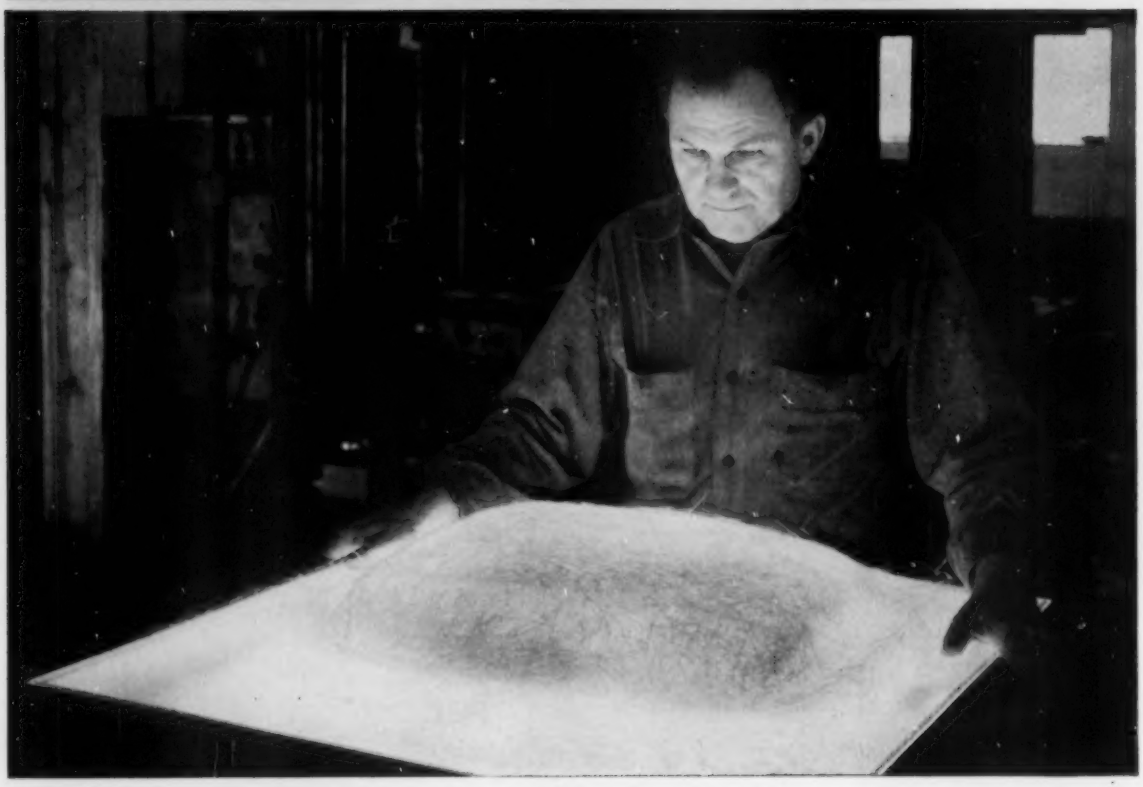
MAIL THIS COUPON FOR PROMPT ACTION

- ☐ Have Field Engineer call at once
- ☐ Have Field Engineer stop by soon
- ☐ For the present, just send complete catalog information on Hannifin cylinders including prices

Hannifin Corporation, 525 S. Wolf Rd., Des Plaines, Ill.

Name.....*Title*.....
Company.....
Address.....
City.....*Zone*.....*State*.....

REINFORCEMENT News from L·O·F GLASS FIBERS COMPANY



'Inspection of preform before molding. Polyester resin is added and final cure made at 1300 PSI and 235°F. The high pressure is used to assure uniform density and smoothness!

Garan® Roving gives domes of Conoco pumps maximum translucency and weatherability!

"The favorable preforming and molding characteristics of L·O·F Glass Fibers' Garan Roving were essential in preforming domes for gasoline pumps that Tokheim Corporation manufactures for the Continental Oil Company. Garan Roving enabled us to make a part with maximum translucency, clarity of color and weatherability . . . with minimum fiber pattern."

Armored Plastics Division
City Auto Stamping Co.
Toledo, Ohio

R. S. Bevelin

L·O·F Glass Fibers' exclusive Garanized roving imparts great flexural and tensile strength to reinforced plastics. It bonds strongly and uniformly with polyester molding resin. Such plastics, reinforced with Garan Roving, are stronger and have higher wet-strength retention.

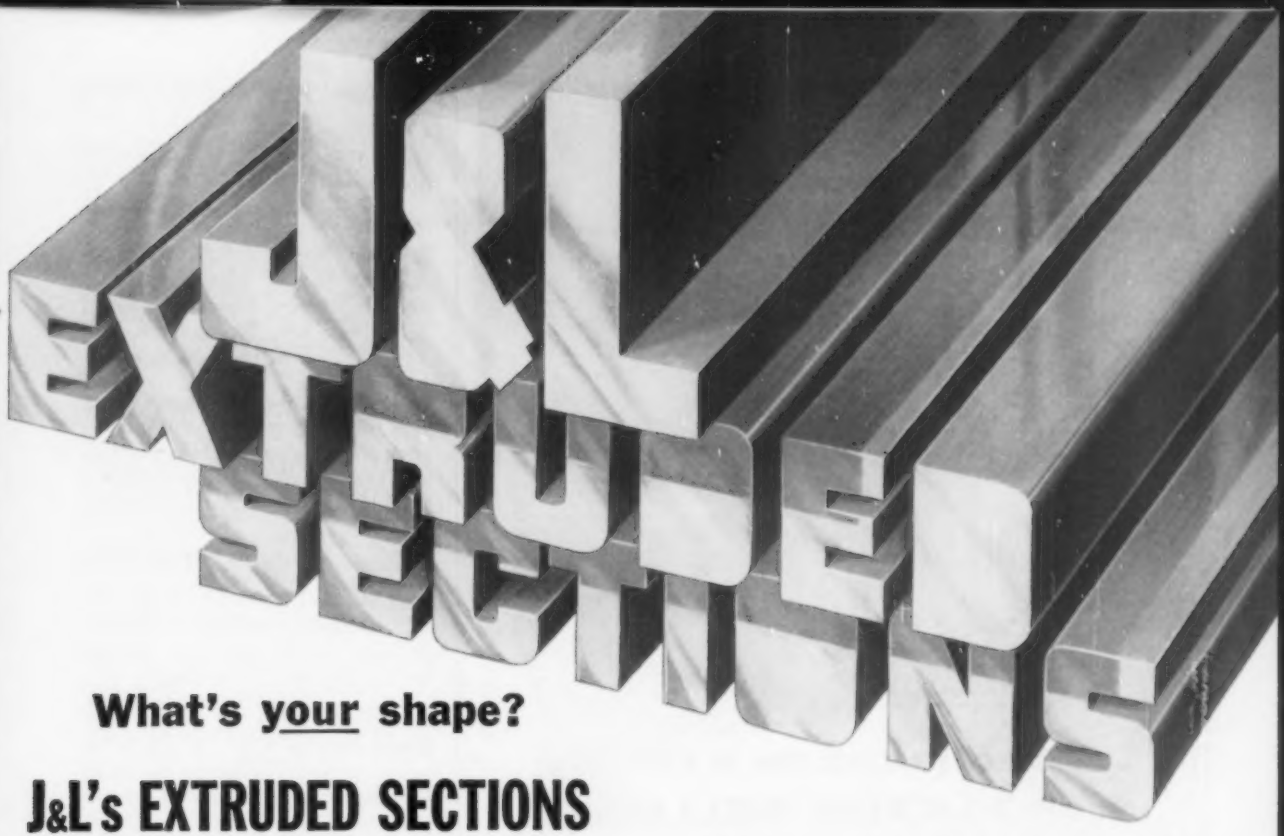
For many molding applications with epoxy, silicone and polyester resins, Vitron Roving is finding wide use.

For technical counsel on how Garan or Vitron Roving can improve your product, contact our nearest sales office, or write: L·O·F Glass Fibers Company, Dept. 4-16, 1810 Madison Avenue, Toledo 1, Ohio.

L·O·F GLASS FIBERS Garan ROVING

L·O·F GLASS FIBERS COMPANY

TOLEDO 1, OHIO



What's your shape?

J&L's EXTRUDED SECTIONS

(Hot Extruded and Cold Drawn)

can be custom-made quickly and economically

Now your complex sections can be *custom-made* at J&L's new Hot Extrusion Plant. On J&L's new equipment, they can be preformed to the predominating cross section of the part you wish to produce.

The range of sections that can be custom-made for you is almost unlimited. Quantities are extremely flexible. Production of single extrusions, where necessary, can be arranged.

In addition, J&L's Extruded Sections possess the physical benefits and accurate tolerances derived from cold drawing. And, you can obtain them in a wide range of analyses.

Send your inquiry today!

J & L EXTRUDED SECTIONS
help speed production
reduce over-all costs

J&L STEEL

Jones & Laughlin
STEEL CORPORATION — *Pittsburgh*

With J&L's Extruded Sections you can:

1. Eliminate time and costs in machining operations.
2. Eliminate time and costs in finishing operations.
3. Reduce scrap losses practically to the zero point.
4. Eliminate the cost of castings and forgings of intricate sections requiring considerable machining.

USE THIS HANDY COUPON

Jones & Laughlin Steel Corporation
3 Gateway Center, Dept. 409, Pittsburgh 30, Pa.

I am interested in knowing what your Extruded Sections can do for me.

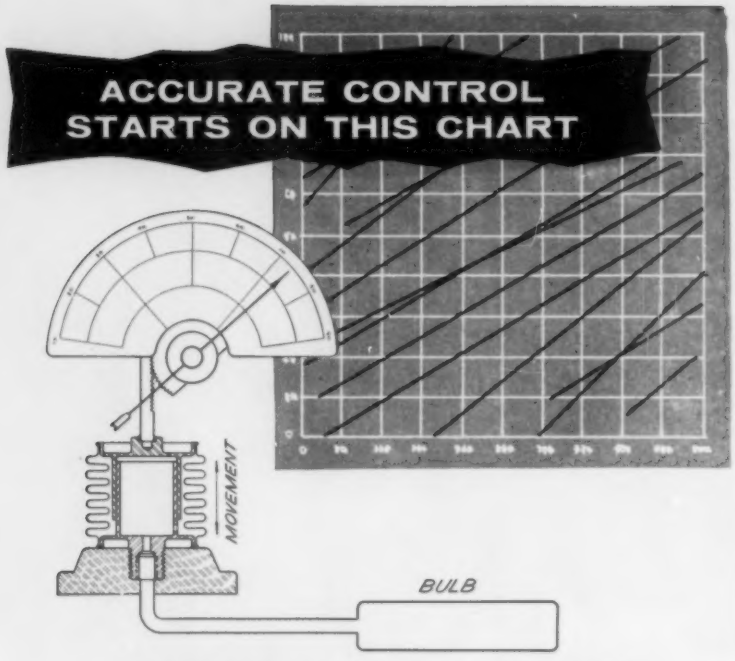
NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE _____ STATE _____



. . . and is made a reality with FLEXON BELLOWS

An important consideration in many bellows applications is the charge. The chart illustrated above is a key factor in the selection of a charging medium that will give you the kind of control performance you require at the lowest possible cost. The vapor pressure—temperature characteristics of 24 of the most widely used charging media are plotted on the chart. Utilizing this data, cost-conscious Flexonics engineers can recommend precisely the best medium for your requirements.

Care and know-how in the selection of charging media is just one step in the procedure followed at Flexonics to get the right combination of performance and economy. Flexonics engineers know and understand controls. It is always their goal to develop functional controls that are easy and economical to make . . . controls that are reliable, long lived and *cost-engineered*.

We would like the opportunity to examine your requirements in bellows-actuated controls. We may be able to show you the way to lower costs. Send an outline of your requirements.

THE FLEXON BELLOWS DESIGN GUIDE

Here are 20 pages full of the vital information you need on bellows application and design problems, including specifications for Flexon brass, stainless steel and monel bellows. A copy of the vapor pressure-temperature curves chart described above is also included. Ask for a copy of Catalog No. 140. There is no obligation.

Flexonics *Corporation*

FLEXON BELLOWS DIVISION

1351 S. THIRD AVENUE • MAYWOOD, ILLINOIS

FORMERLY CHICAGO METAL HOSE CORPORATION

Flexon identifies products of Flexonics Corporation that have served industry for over 53 years.

Manufacturers of flexible metal hose and conduit, expansion joints, metallic bellows and assemblies of these components.
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Catalogs and Bulletins.....continued

Louis Allis Co., 427 E. Stewart St., Milwaukee 7, Wis.

Circle 108, inside back cover

Selenium Rectifiers–Bulletin, 4 pp, describes line of high temperature rectifiers. Sarkes Tarzian, Inc., 415 N. College Ave., Bloomington, Ind.

Circle 109, inside back cover

Hydraulic Tube Fittings–Catalog 4301, 20 pp, provides dimensional information on straight thread fittings with O-ring sealing. Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle 110, inside back cover

Clad Metals–Data folder, 30 pp, contains material on copper-clad steel and steel-clad copper products. Joseph Kinney Co., Inc., Carnegie, Pa.

Circle 111, inside back cover

Relays–Bulletin CH1, 4 pp, gives specifications and contains mounting information, type of enclosures available and basic size information. Aemco Inc., Mankato, Minn.

Circle 112, inside back cover

Magnetic Materials–Bulletin GC-106A, 11 pp, describes various types of magnetic alloys used for permanent magnets, tape-wound cores, powder cores, cut cores. Arnold Engineering Co., Marengo, Ill.

Circle 113, inside back cover

Interval Timer–Bulletin, 2 pp, describes electrical timer able to control sixteen different circuits. Soreng Products Corp., 9555 Soreng Ave., Schiller Park, Ill.

Circle 114, inside back cover

Steel Industry Statistics–Booklet, 72 pp, covers development of raw material reserves, expansion of steel-making capacity, distribution of products, wages, hours and working conditions, and financial data. American Iron and Steel Institute, 350 Fifth Ave., New York 1, N. Y.

Circle 115, inside back cover

PVC Pipe Fittings and Flanges–Booklet, 12 pp, discusses industrial applications of PVC piping and gives complete specifications for threaded and socket types of PVC fittings and flanges, in both normal and high im-

(Continued on page 315)

pact grades. Tube Turns Plastics, Inc., 2929 Magazine St., Louisville 11, Ky.

Circle 116, inside back cover

Ruling and Drawing Devices—Catalog, 19 pp, describes rulers, protractors, templates, dividers, slide rules, triangles, curves, other drafting instruments. C-Thru Ruler Co., Hartford, Conn.

Circle 117, inside back cover

Piston Packing—Bulletin 5503, 16 pp, describes composition packing cups for pistons of air cylinders, hydraulic cylinders and reciprocating pumps. Darling Valve & Mfg. Co., Williamsport, Pa.

Circle 118, inside back cover

Heat—Bulletin 90030, 8 pp, discusses heat transfer area, oil circulation rate, auxiliary pumps, power pumps and pipes and valves. Oilgear Co., 1578C W. Pierce St., Milwaukee 4, Wis.

Circle 119, inside back cover

Cold-Finished Steel Bars—Bulletin 16, 32 pp, "Residual Stresses in Cold-Finished Steel Bars and their Effect on Manufactured Parts" is the title of this pocket-size booklet. Specific subjects covered include residual stresses in cold drawn bars, turned bars, ground bars, heat-treated steel as well as discussions of fatigue, cracking, machinability, tolerances and corrosion. La Salle Steel Co., Hammond, Ind.

Circle 120, inside back cover

Forgings—Booklet, 8 pp, entitled "What Is a Forging?" describes how the forging idea originated and grew, how forgings are made. Drop Forging Assn., 419 S. Walnut St., Lansing 33, Mich.

Circle 121, inside back cover

Powder Metallurgy—Bulletin, 18 pp, includes summary of process, designing for powder metallurgy, typical applications. Keystone Carbon Co., St. Marys, Pa.

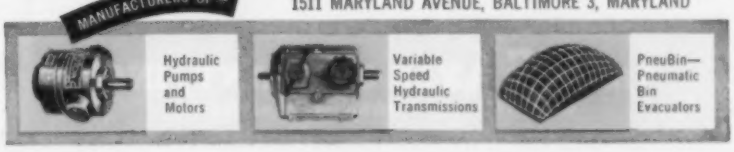
Circle 122, inside back cover

Aluminum Bronze Alloys—Booklet, 32 pp, has information on the properties, composition and functions of aluminum bronze alloys as furnished in sand, centrifugal, investment and per-

(Continued on page 318)

No self-respecting beaver would ever build his dam without sufficient spillways to carry-off superfluous water. This *positive overload protection* is instinctive with the beaver . . . and the new GEROTOR VARIABLE SPEED HYDRAULIC TRANSMISSION. This transmission protects against overload damage to the drive motor, transmission and driven machine. Get the facts on the low maintenance, high efficiency GEROTOR VARIABLE SPEED HYDRAULIC TRANSMISSION today . . . WRITE:

GEROTOR
MAY CORPORATION
MANUFACTURERS OF—
1511 MARYLAND AVENUE, BALTIMORE 3, MARYLAND



U. S. AXLE has long been famous for custom-made precision shafts, machined from finest alloy steels. Now, with the addition of new shot peening equipment, U. S. "Custom-Engineered" Shafts can be *made up to 5 times tougher*, for extra advantages in every type of product.

LIGHTER WEIGHT
Extra strength permits using shafts of smaller diameter, reducing weight.

LONGER LIFE
In actual torsion tests, U. S. shot peened shafts outlasted unpeened shafts approximately 5 to 1!

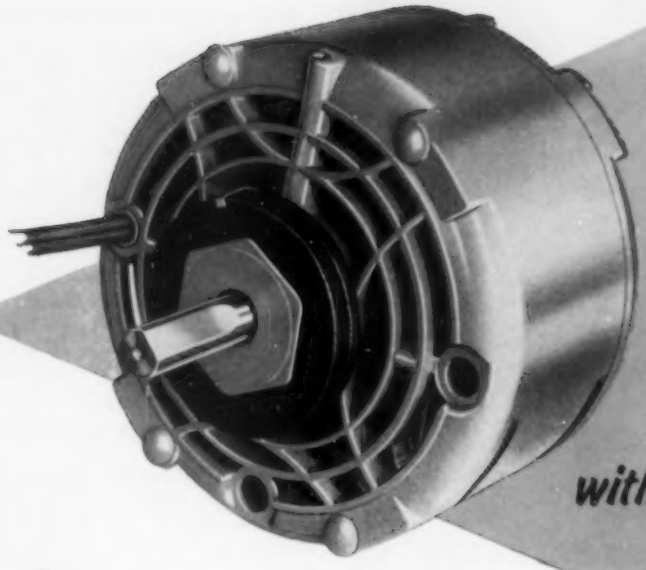
"THE WORLD TURNS ON U. S. AXLES"

"Custom-Engineered"
AXLE SHAFTS
for every application

This illustrated folder will show you why U. S. AXLE is your best source for precision-made special shafts. Write for your copy today.

For a prompt quotation on a U. S. "Custom-Engineered" Shaft, to meet your needs, send us your blueprints and specifications.

THE US AXLE COMPANY, INC.
Since 1920 • Pottstown, Pennsylvania



Super SHADED POLE MOTOR

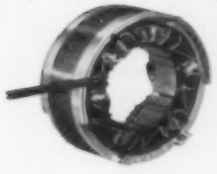
with All the good features

for air conditioning and air moving applications

You will boost sales by teaming your product with Lamb Electric *Super* Shaded Pole Motors. They will give your product the motor advantages of *long life, quiet operation, high operating efficiency, and lasting good appearance.*

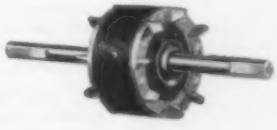
Behind Lamb Electric *Super* Shaded Pole Motors is our 40 years' experience working with manufacturers of household appliances, such as food mixers, sewing machines, floor polishers and vacuum cleaners . . . experience that has resulted in these 10 features:

- "UNI-SPUN" STATOR FRAME for maximum rigidity
- FORMVAR INSULATED WIRE WINDINGS for high strength and insulation resistance
- "AL-SPUN" ALUMINUM ROTOR CAGE for maximum conductivity
- DIE-CAST END FRAMES . . . sturdy, lightweight, corrosion-resistant
- BEARINGS widely spaced, amply dimensioned
- AMPLE OIL RESERVOIR . . . positive oil circulation
- SHAFT precision ground to controlled surface finish
- MOUNTING absorbs vibration
- ADVANCED DESIGN, quality materials, and up-to-date manufacturing methods
- FINISH . . . moisture and abrasion-resistant



"UNI-SPUN" STATOR FRAME

Anchored laminations, ample back iron, strong pole tips mean core rigidity, better heat dissipation, quiet operation.



"AL-SPUN" ALUMINUM ROTOR CAGE

Heat-treated for lowest rotor losses. Integral cooling fan and vented core. Dynamically balanced.

Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

FLASH DRAINAGE!

Cambridge

WOVEN WIRE CONVEYOR BELTS

permit continuous washing, degreasing, quenching

Open mesh construction permits rapid drainage of process solutions, moving belt eliminates batch handling to provide continuous pickling, quenching, tempering, washing, degreasing. All-metal belt resists corrosion even under the most severe conditions.

In continuous heat treating installations Cambridge Woven Wire Conveyor Belts are impervious to damage at temperatures up to 2100°F. They have no seams, lacers or fasteners to wear more rapidly than the body of the belt . . . no localized weakening. Open mesh construction lets heat and gases circulate freely all around the work for uniform treatment.

No matter how you look at it, CAMBRIDGE Woven Wire Conveyor Belts are invaluable aids to AUTOMATION . . . eliminate profit-stealing batch and hand operations. They are made in any size, mesh or weave, and from any metal or alloy. Special raised edges or cross-mounted flights are available to hold your product during movement.

Here's how a Cambridge belt permits CONTINUOUS WASHING. Stamping and drawing compounds, and metallic particles are washed through open mesh.

Call in your Cambridge Field Engineer to discuss how you can cut processing costs by continuous operation. You can rely on his advice. Write direct or look under "Belting, Mechanical" in your classified telephone book.

ASK FOR FREE 130-PAGE REFERENCE MANUAL illustrating and describing woven wire conveyor belts. Gives mesh specifications, design information and metallurgical data.

The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

DEPARTMENT P, CAMBRIDGE 1, MARYLAND

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

manent mold castings, hammer forgings and heat-treated and machined parts. WW Alloys, Inc., 11714 Cloverdale Ave., Detroit 4, Mich.

Circle 123, inside back cover

Vibration Mountings—Catalog SS-55, 4 pp, describes construction details, methods of damping excursion, controlling sway and thrust, load capacities and dimension tables. T. R. Finn & Co., Inc., 200 Central Ave., Hawthorne, N. J.

Circle 124, inside back cover

Counters and Actuators—Catalog E-100, 8 pp, shows line of electrically operated counters with count life ratings from 200 million to 3 million. Production Instrument Co., 702-10 W. Jackson Blvd., Chicago 6, Ill.

Circle 125, inside back cover

Magnetic Clutches and Brakes—Catalog 955, 8 pp, covers line of miniature magnetic clutches and brakes. Dial Products Co., 9 Ave. E., Bayonne, N. J.

Circle 126, inside back cover

Beryllium Products—Product directory, 20 pp, lists and describes the characteristics of the company's line of beryllium copper, beryllium aluminum and beryllium nickel alloys; of beryllium metal and beryllium oxide; of wrought, forged and cast beryllium copper alloys, beryllium copper safety tools. Beryllium Corp., Reading, Pa.

Circle 127, inside back cover

Hard-Surfacing—Data sheets describe line of hard surfacing alloy-filled tubes. Coast Metals, Inc., Little Ferry, N. J.

Circle 128, inside back cover

Indicator Lights—Brochure L-200, 4 pp, describes oiltightness, dusttightness, omnidirectional light spread. Diallight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.

Circle 129, inside back cover

Expansion Joints—Catalog E 2-55, 11 pp, describes line of packless joints used for flexible piping connections. T. R. Finn & Co., Inc., 200 Central Ave., Hawthorne, N. J.

Circle 130, inside back cover

Rigid PVC Pipe—Bulletin 24, 28 pp, describes pipe in sizes ranging from

(Continued on page 319)

¼ to 6 ID. National Tube Div., United States Steel Corp., 525 William Penn Pl., Pittsburgh 30, Pa.

Circle 131, inside back cover

Control Transformers–Catalog GED-2767, 32 pp, includes autotransformers, machine tool transformers, and special application models. General Electric Co., Schenectady 5, N. Y.

Circle 132, inside back cover

Stainless Fasteners–Data book, 52 pp, includes illustrations, thread and size specifications, and availability in a variety of corrosion resistant metals of forty basic fastening devices. Engineering data relating to the composition, properties, applications, and weights of stainless steels is also provided. Allmetal Screw Products Co., Inc., Garden City, N. Y.

Circle 133, inside back cover

Sound–Bulletin 120, 34 pp. Fourth printing of this publication discusses sound, phenomena, theory of sound and some enginering aspects. Burgess-Manning Co., Libertyville, Ill.

Circle 134, inside back cover

Hydraulic Equipment–Catalog describes pumps, rams, valves. Donnell Hydraulic Co., Marengo, Ill.

Circle 135, inside back cover

Hydraulic Equipment–Catalog, 14 pp, explains basic purposes of hydraulic horsepower, and has a chart showing component parts needed for producing and controlling hydraulic power. Char-Lynn Co., 2843-26 Ave. S., Minneapolis, Minn.

Circle 136, inside back cover

Numerical Indicator–Folder, 4 pp, describes device for reporting values of rapidly changing variables. Streeter-Amet Co., 4101 Ravenswood Ave., Chicago 13, Ill.

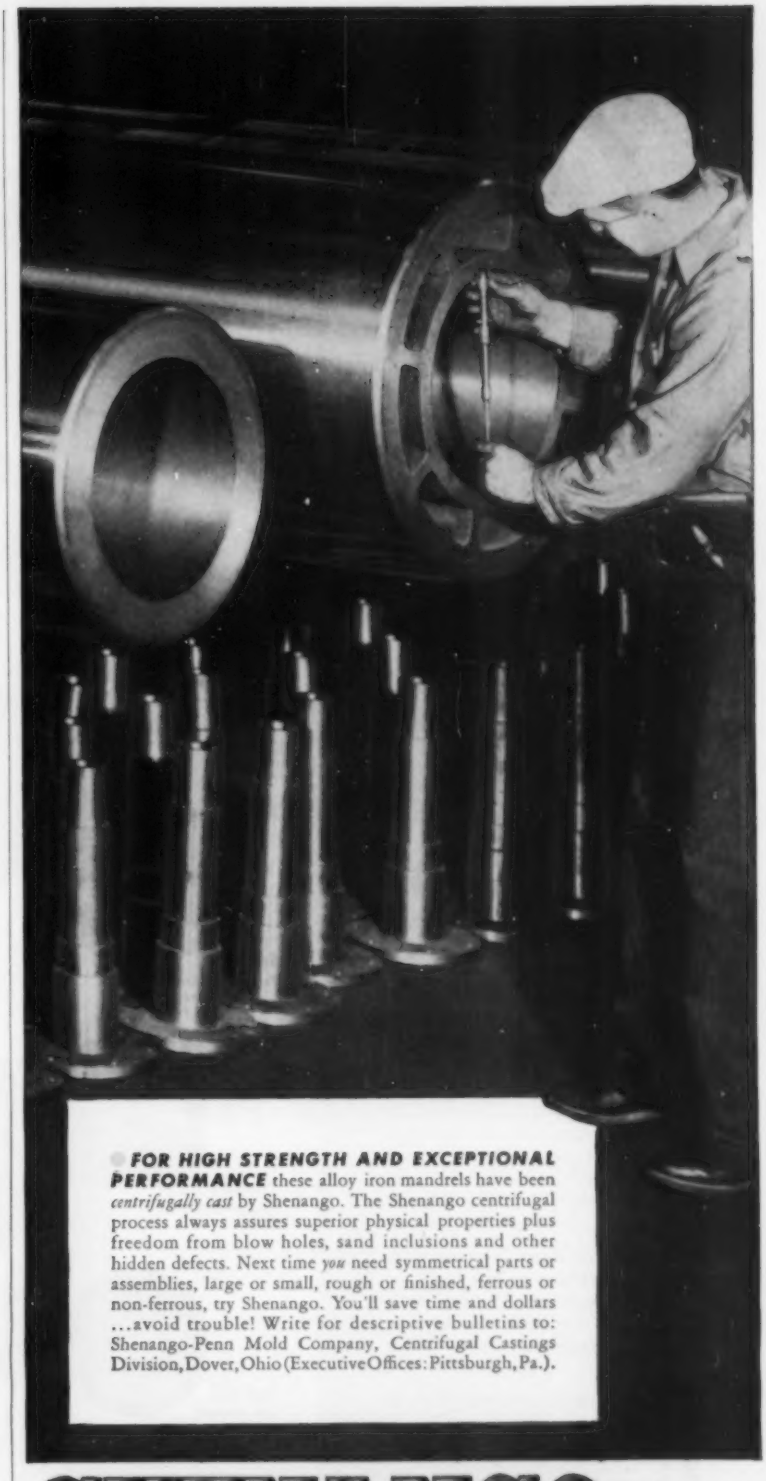
Circle 137, inside back cover

Rotary Stepping Switches–Booklet, 8 pp, describes line of switches for self-interrupted or impulse-interrupted operation. Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill.

Circle 138, inside back cover

Relays–Booklet, 11 pp, describes line of telephone-type, a-c and d-c relays.

(Continued on page 320)


FOR HIGH STRENGTH AND EXCEPTIONAL PERFORMANCE these alloy iron mandrels have been centrifugally cast by Shenango. The Shenango centrifugal process always assures superior physical properties plus freedom from blow holes, sand inclusions and other hidden defects. Next time you need symmetrical parts or assemblies, large or small, rough or finished, ferrous or non-ferrous, try Shenango. You'll save time and dollars ...avoid trouble! Write for descriptive bulletins to: Shenango-Penn Mold Company, Centrifugal Castings Division, Dover, Ohio (Executive Offices: Pittsburgh, Pa.).
SHENANGO
CENTRIFUGAL CASTINGS
COPPER, TIN, LEAD, ZINC BRONZES • MONEL METAL
ALUMINUM AND MANGANESE BRONZES • NI-RESIST • MEEHANITE METAL

Cramer

RUNNING TIME METERS

Type 631E

Type 640B
Portable reset type

Type 690
Precision totalizer

Type 630E
Flush panel mounted

Type 640E
Fully enclosed, with reset wheel

widest time ranges .. variety of models

The Cramer line of running time meters and time totalizers offers a complete selection for measuring and accumulating time intervals, from the hundredth part of a second to hours.

A variety of types—reset or non-reset . . . meter mounted or portable . . . drum or dial counters—are available to meet your exact requirements, and all are driven by the precision-built, high torque Cramer synchronous motor.

Whether used for research, preventive maintenance, or recording operating characteristics of a machine or system, you'll find a Cramer time totalizer ideal for the job.

Write for Bulletin PB-610.

Cramer TIMING DEVICES

SPECIALISTS IN TIME CONTROL

The R. W. CRAMER CO., Inc.

BOX 7, CENTERBROOK, CONNECTICUT

ICR60B

Catalogs and Bulletins.....continued

Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill.

Circle 139, inside back cover

Relays—Data book, 38 pp, describes a-c and d-c relays, switches and lever, turn and push keys. C. P. Clare & Co., 3101 W. Pratt Blvd., Chicago 45, Ill.

Circle 140, inside back cover

Pressure Ratio Indicator—Bulletin 361, 4 pp, gives specifications and characteristics of pressure ratio indicating system. Norden-Ketay Corp., 99 Park Ave., New York 16, N. Y.

Circle 141, inside back cover

Fhp Motors—Catalog 54-A, 6 pp, describes universal, d-c, shaded pole, induction motors. Howard Industries, Inc., Racine, Wis.

Circle 142, inside back cover

Limit Switch—Folder, 4 pp, describes hermetically sealed switch available with contact arrangements up to double-pole double-throw. Electro-Snap Switch and Mfg. Co., 4218 W. Lake St., Chicago 24, Ill.

Circle 143, inside back cover

One-Way Impulse Switch—Folder, 4 pp, describes high capacity basic switch in die-cast case having integral linear actuator. Electro-Snap Switch & Mfg. Co., 4220 W. Lake St., Chicago 24, Ill.

Circle 144, inside back cover

Electrical Connectors—Catalog A4, 80 pp, describes line of connectors for power, signal and control circuits. American Phenolic Corp., 1830 S. 54 Ave., Chicago 50, Ill.

Circle 145, inside back cover

Two-Hand Clutch Controls—Catalog 65, 11 pp, describes line of safety controls for production equipment such as various kinds of presses. Micro Switch, Freeport, Ill.

Circle 146, inside back cover

Potentiometers—Booklet, 19 pp, describes line of precision, linear potentiometers, counting dials, motors. George W. Borg Corp., 120 S. Main St., Janesville, Wis.

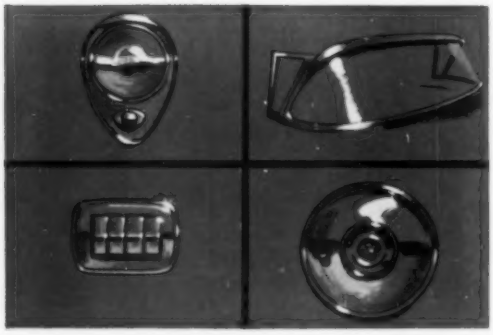
Circle 147, inside back cover

Analog-to-Digital Converter—Catalog 58-10, 15 pp, describes data handling

(Continued on page 324)

modern design specifies stainless steel

McLouth
STAINLESS
Steel
for automobiles



The beautiful bright molding and trim that style your car are made of non-corrosive, easy to clean Stainless Steel. Designers of automobiles and hundreds of other products specify Stainless Steel for its many valuable properties.

For the product you make today and the product you plan for tomorrow specify McLouth high quality sheet and strip Stainless Steel.

McLouth Steel Corporation
Detroit, Michigan

MANUFACTURERS OF STAINLESS AND CARBON STEELS

Advantages of Worm Gearing

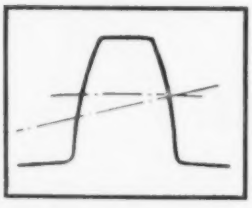
By J. E. GUTZWILLER

Assistant Chief Engineer, Worm Gearing Department

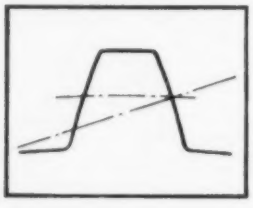
De Laval Steam Turbine Company

Interchangeability—The De Laval Steam Turbine Company was one of the first, if not the very first, manufacturer of heavy duty machinery to build worm gearing with interchangeable parts manufactured under limit gage control. Thus, worm and gear sets of like center distances but of different ratios can be readily interchanged if revision of speeds becomes necessary. Standard parts are always available for maintenance.

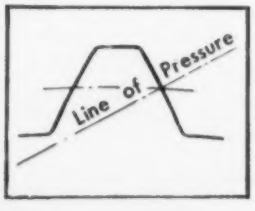
High Shock Load Capacity—The worm gear tooth form is such that the gear teeth are under a crushing, rather than a bending load. For this reason extremely high momentary and shock loads, damaging to many forms of gearing, can be successfully withstood. High momentary overloads seldom cause failure, as worm gear ratings are figured on the wear resistance of the gear teeth.



Standard 14½° involute spur gear tooth and old time worm tooth.



20° stub gear tooth.



De Laval Worm Gear Tooth. Note, line of pressure falls inside base of tooth.

Long Life—Bronze gear teeth maintain their correct form due to the regenerating action of the hardened steel worm, which retains its original shape throughout years of wear. A worm gear drive actually improves with service. This fact is peculiar to worm gearing and contributes to its recognized long life.

Smooth, Quiet Power—De Laval worm gearing transmits power by a continuous shockless action. Three or more teeth are in contact at all times, giving an even flow of torque and uniform angular velocity and eliminating vibration, pulsation, chatter and customary gear noises.

Compact Right Angle Drive—The use of worm gearing makes a neat, closely coupled, compact drive, with the motor shaft at right angles to that of the driven machine.

Larger Gear Ratios Simplify Design—Worm gearing offers larger ratios of speed reduction in a single compact set, another space-saving feature for the design engineer. The larger gear ratios obtainable in a single worm and gear set reduce the number of moving parts required.

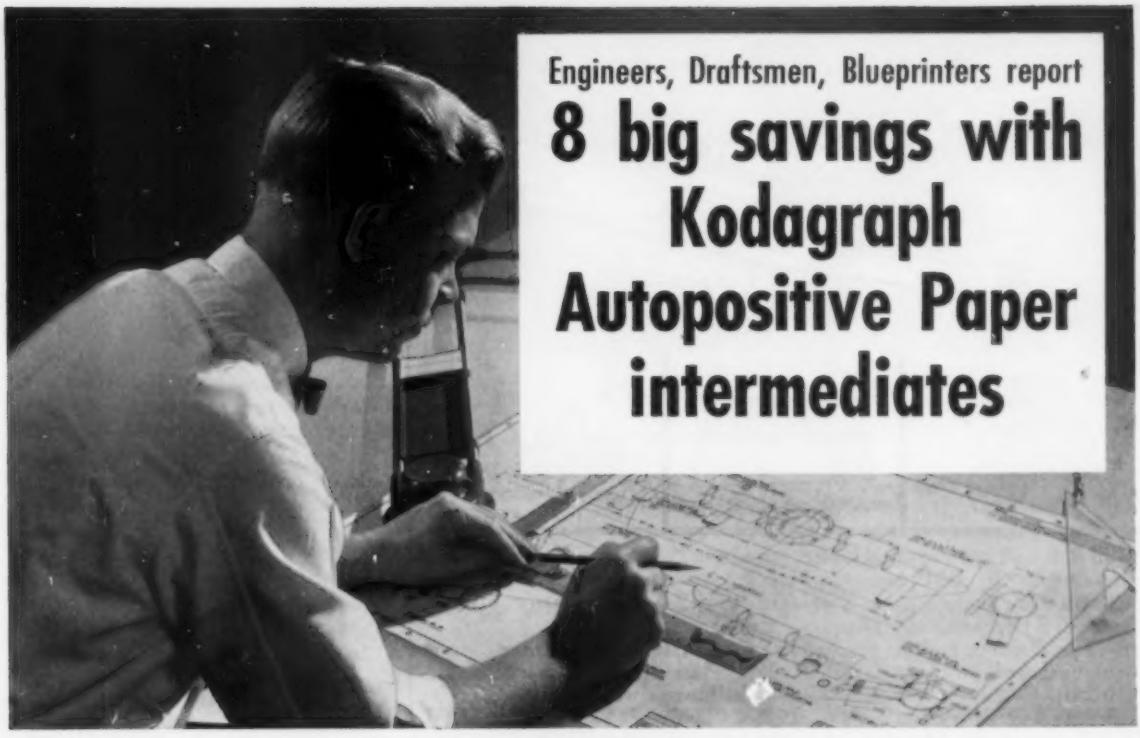
Safety and Ease of Maintenance—The small number of moving parts in a worm gear drive may be readily enclosed, thus avoiding the hazard of exposed moving parts. Assuming proper lubrication, worm gearing operates with minimum attention, even under the most adverse conditions.

Reference Manual On Worm Gear Sets

Design engineers will find this new catalog a helpful working tool in the selection of worm gear sets. It contains examples of how to select worm gearings, worm and gear data, standard worm mounting dimensions, horsepower ratings, data on shaft stresses as well as other information.

Write on your business letterhead for Catalog 5000 to **De Laval Steam Turbine Company, 801 Nottingham Way, Trenton 2, New Jersey.**

DL 285



Engineers, Draftsmen, Blueprinters report

8 big savings with Kodagraph Autopositive Paper intermediates

Revolutionary Kodagraph Autopositive Paper, which produces positive photographic intermediates *without a negative step or dark room handling,* brings these savings to drafting rooms large and small.

1. Protects original drawings. Low-cost Autopositive Paper intermediates are used instead of valuable originals in printmaking, reference, mailing, and making revisions.

2. Reclaims drawings which are old, worn, or soiled. Reproducing them on Autopositive Paper cleans up backgrounds, strengthens line detail . . . eliminates redrafting.

3. Improves legibility of prints. Blueprints or direct-process prints made from Autopositive Paper intermediates are consistently easier to read than prints made from original drawings.

4. Reproduces "unprintable" originals. When extra copies are needed of blueprints, drawings on opaque stock, two-sided originals, and other "unprintables," just reproduce them on Autopositive Paper *and you have your printmaking masters.*

5. Speeds revisions of drawings. A popular short cut is to cut out or eradicate detail on an Autopositive Paper intermediate . . . and then add the new detail to this print or one made from it.

6. Eliminates redrafting standard component designs. From a file of standard component designs made on Kodagraph Autopositive Film, select the ones needed and attach to drawing form with translucent tape. Then reproduce on Autopositive Paper, add new detail and the job is done.

7. Simplifies print distribution. Instead of shipping bundles of production prints, send Autopositive Paper intermediates. Mailing costs are saved. Required number of prints can be made at other end. No overstocking this way . . . or running short of prints.

8. Provides photo-lasting copies. Autopositive Paper intermediates, with dense black photographic lines on a translucent white paper base, will not turn yellow or become brittle in the files; will produce sharp, legible prints whenever needed.

New illustrated booklet gives full story on Kodagraph Autopositive Paper, which you, or your local blueprinter, can process readily with existing printmaking equipment and standard photographic processing.

Kodagraph Reproduction Materials

MAIL COUPON FOR FREE BOOKLET

EASTMAN KODAK COMPANY
Graphic Reproduction Division, Rochester 4, N. Y.

Gentlemen: Please send me a free copy of your new booklet on Kodagraph Reproduction Materials. 15

Name_____

Position_____

Company_____

Street_____

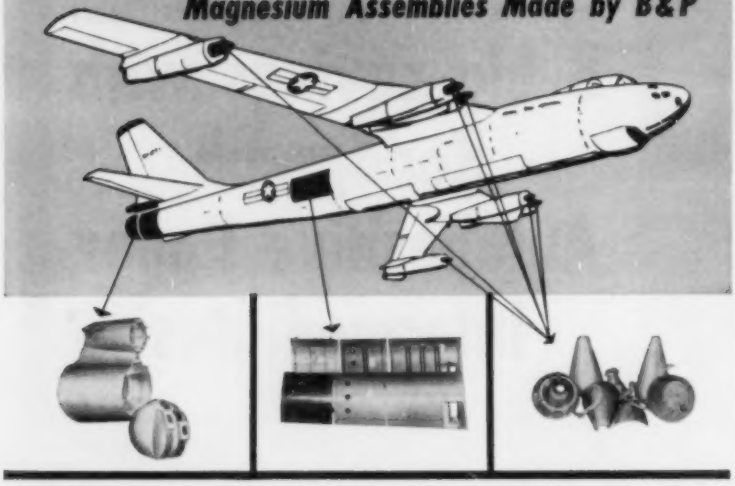
City_____

Zone_____ State_____

Kodak
TRADE MARK

IN THE BOEING B-47 BOMBER:

Magnesium Assemblies Made by B&P



Tail cone and gun turret enclosure are supplied by B&P to General Electric Co.; smooth panel doors made for Lockheed and Douglas B-47 production; and the inboard and outboard jet pods for Bell Aircraft Co. In addition, B&P produces magnesium cases and components for electronics systems in the B-47 and many other military planes.

Write for folder describing B&P's facilities for magnesium and titanium work.

BROOKS & PERKINS, INC. 1956 W. Fort St. Detroit 16, Mich.

Offices in New York, Washington, Los Angeles and Dallas

Another of the Reasons Behind Brad Foote Quality—

TOOTH SPACING

• 99% of gear drawings do not specify tooth spacing. For most applications, industry generally believes that competent gear manufacturers, working by standard AGMA practices, will produce gears within the limitations required for easy assembly and good load transmission.

• Occasionally, however, on very precise jobs you may find it necessary to specify extreme accuracy of tooth spacing and nonadjacent tooth spacing. Applications such as radar mounts, timing mechanisms, indexing mechanisms—all may require closer tooth spacing tolerances than are obtainable with average equipment in the hands of regular gear manufacturers.

• BRAD FOOTE welcomes precision jobs like these. We can add to highly specialized equipment specific experience in meeting this, as well as many other demanding requirements for special gear production.

• Prove to yourselves the savings that BRAD FOOTE quality can mean. Let us quote on the gear requirements for your next program.

BRAD FOOTE MAKES ALL TYPES OF GEARS—IN A COMPLETE RANGE OF STYLES AND SIZES

BRAD FOOTE GEAR WORKS, INC.

1309 South Cicero Avenue • Cicero 50, Illinois

Bishop 2-1070 • OLympic 2-7700 • TWX-CIC-2856-U

subsidiaries | AMERICAN GEAR & MFG. CO. Lemont, Illinois Phone Lemont 920 • PITTSBURGH GEAR COMPANY Phone SPalding 1-4800 Pittsburgh 25, Penn.

and reduction device. Fischer & Porter Co., Hatboro, Pa.

Circle 148, inside back cover

Electro-Mechanical Integrator–Bulletin, 2 pp, describes velocity servo package used for control of motor speeds. Feedback Controls, Inc., 1332 N. Henry St., Alexandria, Va.

Circle 149, inside back cover

Lattice Mountings–Bulletin 701, 4 pp, illustrates mounting in use on a vibrating screen, foundry shakeout and heavy motor-generator. A list of the additional uses is included. Reference table contains dimension and capacity data. Lord Mfg. Co., 1635 W. 12 St., Erie, Pa.

Circle 150, inside back cover

Counters–Folder, 4 pp, describes batch counter, elapsed time meter. Spencer Mfg. Co., 3253 N. Cicero Ave., Chicago 41, Ill.

Circle 151, inside back cover

Mechanical Tubing–Bulletin TB-360, 4 pp, describes carbon, alloy and stainless steel tubing. Babcock & Wilcox Co., Beaver Falls, Pa.

Circle 152, inside back cover

PVC Pipe and Fittings–Folders, 4 pp each, describes mechanical, thermal, electrical and other desirable properties of two plastic compounds. Alpha Plastics, Inc., 15 Northfield Road, West Orange, N. J.

Circle 153, inside back cover

Steel Reels–Catalog C, 32 pp, describes reels made for air hose, belts, cables. Gleason Reel Corp., 740 N. Plankinton Ave., Milwaukee 3, Wis.

Circle 154, inside back cover

Venturi Tubes and Nozzles–Bulletin 100, 4 pp. Data on advantages, construction and installation details, range of sizes and specifications is given. Simplex Valve & Meter Co., 7 E. Orange St., Lancaster, Pa.

Circle 155, inside back cover

Hose Couplings–Data sheet, 4 pp, has specifications and recommended uses. B. F. Goodrich Co., Akron, Ohio.

Circle 156, inside back cover

Speed Controls–Booklet, 7 pp, describes automatic speed control for

(Continued on page 325)

electronic, pneumatic, hydraulic, mechanical application. Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill.

Circle 157, inside back cover

Machine Tool Clutches—Bulletin 134-B, 12 pp, describes oil type and dry type clutches. Twin Disc Clutch Co., Racine, Wis.

Circle 158, inside back cover

Letterhead Requests Only

Manufacturers who published following literature ask that requests for copies be made on company letterheads.

Rubber Rolls—Handbook, 60 pp, contains information concerning every phase of roll manufacture, characteristics, applications, operation and maintenance. Rodney Hunt Machine Co., Orange, Mass.

Quick-Connect, Disconnect Coupling—Bulletin 240, 4 pp, describes uses and construction. Snap-Tite, Inc., Union City, Pa.

Thermistors—Data book, 36 pp, gives historical background, operating characteristics, typical applications and engineering data. Victory Engineering Corp., Springfield Road, Union, N. J.

Nickel Silver and Phosphor Bronze—Catalog, 60 pp, gives information on line of nickel silver and phosphor bronze alloys supplied in sheet, strip and coils. Data includes nominal composition, chemical composition requirements, grain size, physical properties, approximate Rockwell hardness, approximate relative machinability, melting point, density, average coefficient of linear expansion per F and electrical conductivity. Waterbury Rolling Mills, Inc., Waterbury, Conn.

Alloy Wire, Ribbon, Strip—Handbook, 150 pp, describes nickel, copper, stainless, non-ferrous alloys for high temperature, electrical, electronic applications. Wilbur B. Driver Co., Newark, N. J.

Potentiometers—Technical paper 573, 9 pp. What happens to the operating characteristics of a precision potentiometer during its working life is the subject. Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif.

You buy savings in metal joining time, labor and materials when you purchase these tried-and-proved low-temperature silver brazing alloys. That's because their low flow points, exceptional fluidity and silver content combine to make brazing a surprisingly fast, simple economical operation.

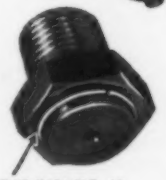
This is particularly true when you use EASY-FLO and SIL-FOS with a setup that "automationizes" the actual brazing.

Here's a typical example...

Photos and data courtesy of ESSCO Industries, Inc., Rochester, N. Y.

•IT TAKES ONLY 4 SECONDS

with EASY-FLO 45, to make an oil and air-tight braze of a threaded spud into the cover of the pressure switch which is part of the Studebaker anti-creep "hill holding" device. Operator merely sets covers on holders on an endless chain, and places in each cover a spud with a ring of EASY-FLO 45 preplaced. Assemblies pass through an induction heating coil 14 a minute.



THIS EASY-FLO 45 RING DOES IT!

Expert brazing production know-how is always at the call of every EASY-FLO and SIL-FOS user without obligation.

WRITE FOR THE "AUTHORIZED DISTRIBUTOR LIST" and get prompt supply from the nearest one.

FOR EASY-FLO AND SIL-FOS FACTS IN PRINT . . . write today for a copy of Bulletin 20.

HANDY & HARMAN

General Offices: 82 Fulton St., New York 38, N. Y.

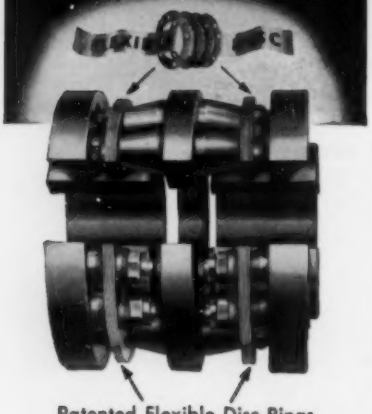
DISTRIBUTORS IN PRINCIPAL CITIES

OFFICES and PLANTS: BRIDGEPORT, CONN. PROVIDENCE, R. I. CHICAGO, ILL. CLEVELAND, OHIO DETROIT, MICH. LOS ANGELES, CALIF. TORONTO, CANADA MONTREAL, CANADA

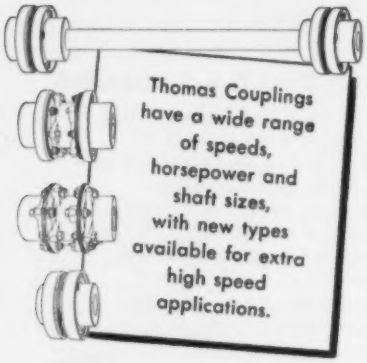
There's no ". . . or equal" for EASY-FLO and SIL-FOS

Specify THOMAS ALL METAL
FLEXIBLE COUPLINGS
for Power Transmission to avoid Costly Shut-Downs

Distinctive Advantages of
THOMAS FLEXIBLE COUPLINGS
- NO MAINTENANCE
- NO LUBRICATION
- NO BACKLASH
- NO WEARING PARTS



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.

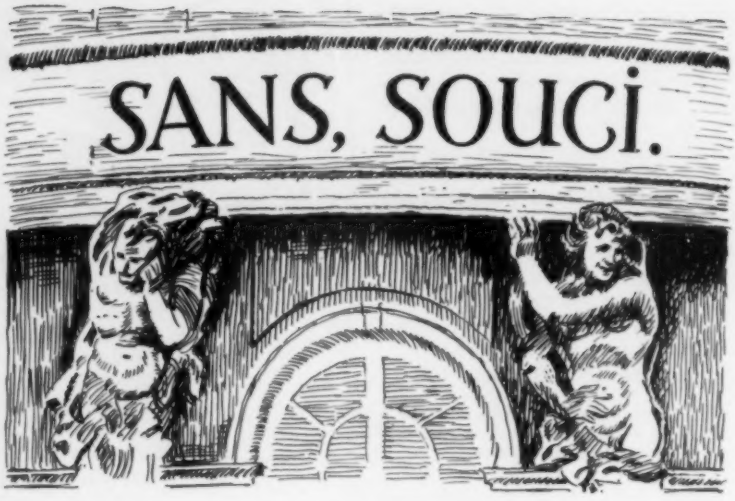


Thomas Couplings have a wide range of speeds, horsepower and shaft sizes, with new types available for extra high speed applications.

THE THOMAS PRINCIPLE GUARANTEES
PERFECT BALANCE UNDER ALL
CONDITIONS OF MISALIGNMENT
NO MAINTENANCE PROBLEMS
ALL PARTS ARE
SOLIDLY BOLTED TOGETHER

Write for our new Engineering Catalog No. 51

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.



Ad Libbing by the Editor

Last month I described how Professor James Hunter Wily got into the business of manufacturing the Big Bang cannons. This was a relatively simple toy that performed with great realism, including a flash and a bang. Now I will tell some of the things that Mr. Wily did in building his business.

One element of the Big Bang cannon was the ammunition chest which was a cube shaped box with a circular hole in the top into which a cover fitted. The hole in the casting was cored and it was necessary to ream it. It aggravated Hunt Wily tremendously to find that after the hole had been reamed, in the usual manner, much time was consumed in getting rid of the chips that had fallen into the box during the reaming operation.

Being a highly methodical man and having no patience with wastefulness, Hunt Wily went to Philadelphia to seek a possible automatic machine which might ream the boxes, holding them upside down so that the chips would fall out of their own accord. He was unable to find such a machine. One manufacturer offered to design and build one but the price was far greater than Hunt could afford to pay in those early stages of his business.

As he told me some time later, he was riding the train back to Bethlehem wondering how he could avoid the wasteful operation of shaking or blowing the chips out of the ammunition chest. It then suddenly dawned upon him that to ream the hole with the ammunition chest in an upside down position, all he had to do was to turn his drill press upside down. So after leaving the train he stopped off in a lumber yard and ordered some 4 x 4 studs. With these he built a cradle to hold his drill press upside down. The hand operated feed now became a foot operated feed. He clamped a slotted piece to the table, the slot being of such dimensions that the ammunition chest would slide through. When he had finished, it was merely necessary for the operator to work his foot up and down and feed the castings into the fixture, an automatic stop mechanism allowing the reamed casting to fall out at the other end of the slot.

This ingenuity was typical of the operation of Hunt Wily's Big Bang Cannon Works. As another example, it irked him every time his janitor had to go to the furnace room to stoke the fire. So Hunt Wiley put in an automatic stoker, or perhaps it was an oil boiler.

The final operation in his plant was the packaging of the Big Bang Cannon. He had purchased a machine which formed the paper boxes automatically and likewise made the covers. But it was necessary for a boy to carry these cardboard boxes to the benches where the cannons were packed into them. The factory formerly had been a residence house and had the conventional stair well. So Mr. Wily put the box making machine in the attic at the top of the stair well and the machine automatic-

(Continued on page 328)

Colson cures

barrel-truck fatigue with

STRONGER BACKBONE FROM OSTUCO

First experimental models of Colson Corporation's barrel and drum handling truck strained, twisted and snapped under loads below their intended 1,000 pound capacity. Failures increased when the Elyria, Ohio, manufacturer tested trucks with heavy loads over rough surfaces.

Tracing trouble to the "Backbone" (the truck's main structural member), Colson and OSTUCO engineers got together, came up with a 1½" square formed seamless tube to solve the fatigue problem. Since 1947, the redesigned drum handling truck has been serving Colson customers, handling loads up to . . . and above . . . its capacity. Successful? Colson has yet to hear of one failure.

Take your cue from Colson. Quality, cost and production problems work themselves out when you talk them over with an OSTUCO engineer. It's easy to start the process by contacting a nearby OSTUCO sales office, or by writing direct to the Shelby factory.

Unique Single-Source Service at OSTUCO eliminates interplant shipment and error . . . another reason why your product can be improved when components are made from

OSTUCO TUBING

SEAMLESS AND ELECTRIC WELDED STEEL TUBING

—Fabricating and Forging

OHIO SEAMLESS TUBE DIVISION

of Copperweld Steel Company • **SHELBY, OHIO**

Birthplace of the Seamless Steel Tube Industry in America

SALES OFFICES: BIRMINGHAM • CHARLOTTE • CHICAGO (Oak Park) CLEVELAND • DAYTON • DENVER • DETROIT (Ferndale) HOUSTON • LOS ANGELES (Beverly Hills) • MOLINE NEW YORK • NORTH KANSAS CITY • PHILADELPHIA PITTSBURGH • RICHMOND • ROCHESTER • ST. LOUIS ST. PAUL • SALT LAKE CITY • SEATTLE • TULSA • WICHITA

CANADA, RAILWAY & POWER ENGR. CORP., LTD.

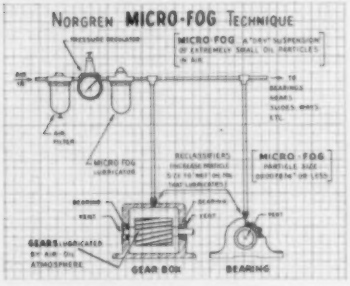
EXPORT: COPPERWELD STEEL INTERNATIONAL COMPANY 117 Liberty Street, New York 6, New York

Better Machine Lubrication Simplified

Norgren Announces the Only Complete Line of Aerosol Lubricators

. . . Now, MICRO-FOG Lubricators are available for 32, 200, 300, and 1000 Bearing Inch Requirements

The Norgren MICO-FOG principle has made practical the application of oil-fog lubrication to large machine tools, lubricating bearings, gears, chains, and other machine parts which always before have been lubricated by splash systems, force feed systems and other methods. Today, Norgren MICRO-FOG Lubricators are providing lubrication for large and small machines in many types of industry.

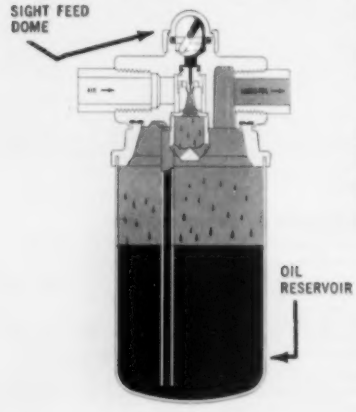


What is Norgren MICRO-FOG?

Norgren MICRO-FOG is an air-borne suspension of extremely small oil particles (.00007874" or less in diameter). Because the oil particles are so small, they can be conveyed long distances through complex piping systems without reclassifying and flooding the lines with oil — a condition heretofore not possible with conventional oil-fog systems.

How is Norgren MICRO-FOG formed?

Air passing through the venturi section of a Norgren MICRO-FOG Lubricator creates a pressure differential that draws oil from the reservoir. The oil is allowed to flow at a controlled rate into the venturi section.



The venturi creates an oil fog, discharging it into the upper regions of the oil reservoir. The heavier particles of oil return to the oil supply. Only the finer particles of 2 microns (.00007874") or less are carried into the air line.

CONTROLS AND FILLER PLUGS EQUALLY ACCESSIBLE FROM BOTH SIDES
360° VISIBILITY OF OIL FLOW
OIL SUPPLY VISIBLE
1 QT. OIL CAPACITY
Norgren Micro-Fog

Model S3406-8S
300 BEARING INCH CAPACITY

Now—A Lubricator for every requirement

New models of MICRO-FOG Lubricators, having 200 and 300 bearing inch capacities, are now being manufactured by Norgren. These are in addition to the 32 and 1000 bearing inch capacity lubricators already in the Norgren line. The range of bearing inch capacities given by these models means that you can select a lubricator that will provide the most efficient lubrication for the job.

For complete information about Norgren MICRO-FOG Lubriation, call your nearby Norgren Representative listed in your telephone directory — or WRITE FOR NEW No. 700 CATALOG.

C. A. Norgren Co.

3428 So. Elati, Englewood, Colo.

ally discharged finished boxes into a chute that led down the stair well and ended at the packing table. Stop-start buttons at the packing table controlled the machine with the result that the six or eight people packaging the Big Bang Cannons needed only to press a button to get more boxes and press another button when enough had arrived.

One of the most fascinating things about that factory was the office. The total office force consisted of Hunter Wily and one girl. Besides taking care of correspondence, sending out invoices, making out the payrolls and all the other chores of office work, this office also sent out mail promotion pieces to the prospective purchasers, namely, hardware stores, top shops and department stores. In showing me this layout, Mr. Wily said, "See, here I have all of the addressograph stencils in these drawers. Each section of drawers covers a different section of the country. And you will notice a label that dates each of these sections. Here we have January the 4th. And that bank of file drawers covers most of New England where they celebrate Bunker Hill Day on June 17th. And then here we have the dates for the Battle of the Alamo in Texas, and that's the way we cover the national holidays all over the country. And then of course we have the 4th of July and Christmas. It is a simple matter for the girl and me to pull out these stacks of stencils, put them on the addressograph machine, run through the envelopes and mail out the material."

That was typical of the manner in which Hunt Wily had mechanized his whole office. The housekeeping was perfect. There was a place for everything and everything in its place. There wasn't a scrap of paper to be seen anywhere. Hunt Wily's business was successful.

About three years ago James Hunter Wiley retired and sold his business which is now operating as the Conestoga Company, Inc., still turning out the toy cannons invented by the late William Suddards Franklin, designed and developed into a successful manufactured product by James Hunter Wily. Both of those men at one time were Lehigh professors, were great teachers and outstanding in other respects also, each in his own sphere.

—G. F. N.

ABSTRACTS

New NEMA Standards

Abstracted from a paper "New NEMA Standards For D-c Motors and Generators", by J. F. Davis, Member AIEE, General Electric Co., Erie, Pa.; presented at AIEE Fall General Meeting, Oct. 3-7, 1955, Chicago, Ill.

A complete revamping of NEMA standards pertaining to d-c motors and generators has been made to bring these standards in line with the modern usage of these machines. The new "Suggested Standards for Future Design" should enable manufacturers of industrial d-c motors and generators to make smaller, lighter, and faster-responding machines with a much higher degree of standardization than under the previous standards. This paper describes the new standards for integral-horsepower motors up to 200 hp and generators up to 150 kw, given in NEMA Standards Publication No. MG1-1955, and tells how and why they were developed.

As a typical example of surveys made recently, one by the General Electric Co. showed that on all recent applications of general purpose d-c motors, approximately 90 per cent were used on adjustable-voltage systems. Very few plants which still have a constant-voltage d-c bus are extending these systems or installing new ones. Of the motors used on constant-potential systems, approximately 80 per cent were adjustable-speed motors and 20 per cent were constant-speed motors. Therefore, less than 5 per cent of the recently purchased general-purpose d-c motors ran at a single speed. A large proportion of the adjustable-voltage drives had only one motor operating off the generator which powered it.

For industrial d-c motors, a new definition has been adopted as a NEMA standard which reads: "An industrial d-c motor is a d-c dripproof motor having a continuous rating and designed, listed and offered in standard ratings with standard operating characteristics and mechanical construction for use under usual service conditions without restriction to a particular application or type of application."

One of the significant features of

(Continued on page 333)

3 New Norgren Air Line Filters *REDUCE WEAR ON AIR-POWERED EQUIPMENT*

New Sizes of Automatic-Drain Filters Added to Norgren Line

Automatic-drain filters for use with ¾" and 1" air lines are now being manufactured by Norgren in addition to their present models for use with ¼", ⅜" and ½" air lines. Three filter elements are available—of 74, 64, and 25 microns.

Norgren Automatic-Drain Air Line Filters filter oil, corrosive moisture, abrasive pipe scale, rust and other solids from compressed air. A float controlled, pilot operated drain mechanism, operating under constant or fluctuating line pressures with or without air flow, automatically drains collected liquids. For trouble-free operation and reduced wear, the solids are prevented from entering the drain mechanism.

Series 11,200
¼", ⅜", ½", ¾", 1"
Pipe Sizes

New Metal Bowl Filter for higher temperatures and pressures

A new model replaceable metal bowl air line filter has been added to the Norgren line. The metal bowl allows the filter to be used at temperatures from —40° to 300° F. and at pressures ranging up to 250 psi.

These filters are designed to create a strong centrifugal force that "wrings" a high percentage of moisture and oil from the air. A baffle traps liquids and solids in the Quiet Zone in the bottom of the bowl and prevents them from re-entering the air line. Three filter elements are available—of 74, 64, and 25 microns.

Series 12,200N
¼", ⅜" Pipe Sizes

New, Better, Low Cost Filter

Norgren is now manufacturing a new, low cost filter for applications where the removal of solids from the air is of primary importance. The replaceable bowl can easily be removed for cleaning or it can quickly be replaced if accidently damaged in use.

The filter part of the unit, a reinforced 200 mesh Monel wire screen or sintered metal filters of 64 and 25 microns, is easily removed for cleaning without removing the entire unit from the air line. There are no moving parts to wear out and the filter functions with a minimum of pressure drop.

Series 30AD
¼", ⅜" Pipe Sizes

There is a Norgren AIR LINE FILTER for every air line need.

C.A. Norgren CO.

3428 So. Elati, Englewood, Colo.

For complete information about Norgren Air Line Filters, phone your nearby Norgren representative listed in your telephone directory—or WRITE FOR NEW No. 700 CATALOG.

PRESSURE REGULATORS • AIR LINE FILTERS • LUBRICATORS • AIR CONTROL VALVES

Road markers by
Plastic Engineering Inc., Cleveland 2, Ohio

This bright red molded road marker makes good use of the inherent toughness of BAKELITE Brand Vinyl Elastomeric Plastics. It's virtually immune to rough treatment. The color goes completely through, can't be scuffed off. The pyramid shape and the correct specific gravity of the plastic keep the marker in place when it's set over a freshly-painted traffic line.

BAKELITE Vinyl Elastomeric Plastics stay resilient even at below-zero temperatures. Their flexibility can be varied from semi-rigid to soft, depending on the amount of plasticizer used in their formulation. A wide range of colors is available. These materials are faithful to mold details and provide high surface gloss.

Vacuum tube bases molded by
Sylvania Electric Products Company, Warren, Pa.

With its excellent high-frequency insulating characteristics, BAKELITE Brand "Low Loss" Phenolic BM-17748 is an ideal material for these molded vacuum tube bases. For example, its minimum dielectric strength is 325 volts/mil, while power factor ranges from 0.025 at 60 cycles down to 0.010 at 1,000,000 cycles. Consequently, this material is recommended for a wide range of electronics applications including coil forms, resistors, and capacitor housings.

BM-17748 is also more resistant to moisture and more dimensionally stable than most phenolic molding materials. It can be used not only where its outstanding electrical properties are paramount, but also in a variety of other applications where these additional service properties are useful.

BAKELITE

TRADE-MARK

GREATEST VARIETY, LARGEST RESOURCES FOR PLASTICS KEYED TO YOUR NEEDS

Your product, its sales and profits depend in great measure on the quality of the materials you specify. That's why so many molders and fabricators rely on Bakelite Company for their basic requirements.

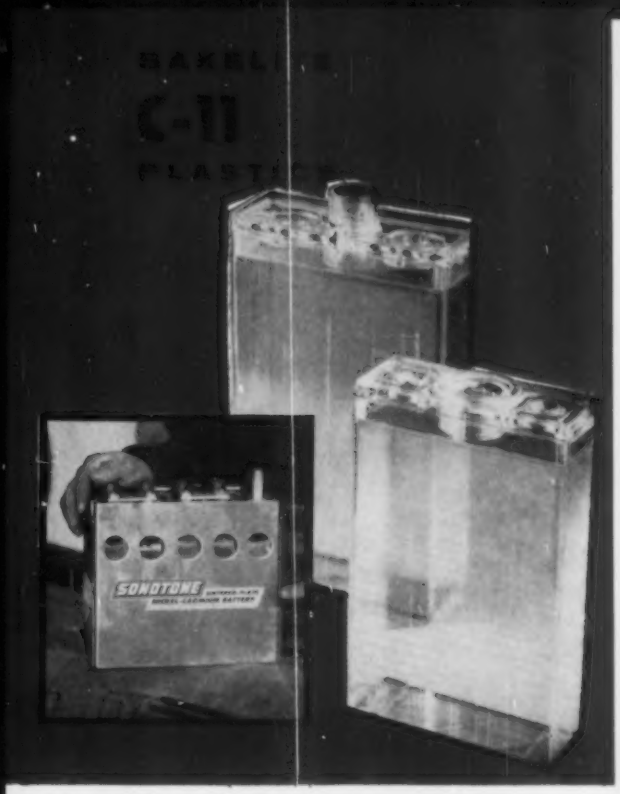
At this one source you can select plastics with properties best suited to your product needs, because Bakelite Company offers the greatest variety of the large volume plastics.

In addition, Bakelite Company engineers—backed by over 45 years of plastics research—offer technical advice or assistance whenever you need it. If you have a problem in materials selection or processing, talk it over with the Bakelite Company sales representative nearest you. Or write Dept. JI-145.

Instrument case molded by **Auburn Button Works, Inc.,** Auburn, N. Y., for Welch-Allyn, Inc., Skaneateles Falls, N. Y.

Cleverly designed, this entire case for diagnostic instruments is one-piece molded of BAKELITE Brand Polyethylene. Compartments, hinge, flaps, and the simulated alligator surface were all formed in a single operation. In service, the resilient polyethylene makes the case shock-proof and virtually indestructible. It can be sterilized in standard germicides; polyethylene is inert to most chemicals.

Although lightest of all commercial plastics, BAKELITE Polyethylene provides husky construction. It's tough and flexible, even at –70 degrees F. Other advantages include outstanding dielectric properties, making it an especially important extrusion material for wire and cable construction.



Cell cases molded by **Plastic Mold and Engineering Co.,** Providence, R. I. for Sonotone Corp., Elmsford, N. Y.

These battery cell cases, molded of BAKELITE Brand C-11 Plastic, are designed to give many years of service, according to the manufacturer. The plastic, an acrylonitrile-styrene copolymer, is so chemical-resistant that it withstands contact with highly corrosive electrolyte—a 30%-by-weight solution of potassium hydroxide in distilled water. It's so tough that a "shake test" shows it can take stresses as high as 500 cycles at 15 G's.

BAKELITE C-11 Plastic is also used for the cover, which is cemented to the case, making the cell a sealed unit with the sole exception of the vent plug. The high degree of transparency found in C-11 Plastic permits visual inspection at all stages of the battery's manufacture.

BAKELITE
BRAND
PLASTICS

PHENOLICS • STYRENES • IMPACT STYRENES
POLYETHYLENES • VINYLS • POLYESTERS
EPOXIES

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N.Y.
In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario
The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

If you need more elbow room... think of your Kaiser Aluminum

You can convert profit-robbing storage space into room for production by using your Kaiser Aluminum Distributor's warehouse as your own.

And look at these other benefits you get!

By using his well-stocked warehouse, you can reduce your overhead through lower insurance and taxes, less accounting, less material damage and lower handling costs. Because he cuts your aluminum to exact size and shape, you can cut down on unnecessary metal-working equipment and eliminate scrap handling.

And your Kaiser Aluminum Distributor is geared to meet your emergency needs the minute you call! Because of his wide experience in the metals field he can specify the exact type of aluminum your product requires. He can suggest methods of using aluminum more economically. He can supply you with small quantities for experimental work.

All these services mean more profits for you because they lower your costs!

Take advantage of the personalized service offered by your Kaiser Aluminum Distributor. Call him today! ⟶

ATLANTA, GEORGIA, Emerson 3451
Warehouse Division, Atlantic Steel Co.
BALTIMORE, MARYLAND, Peabody 2-7300
Hill-Chase Steel Co. of Maryland
BEAUMONT, TEXAS, Phone 4-2641
Standard Brass & Mfg. Co.
BOSTON METROPOLITAN AREA
Hawkridge Bros. Co., Hancock 6-5620
L. E. Zurbach Steel Co., Monument 6-1400
CHICAGO METROPOLITAN AREA
Fullerton Steel & Wire Co., Merrimac 7-2700
Korhumel Steel & Aluminum Co.
Evanston, Illinois, Ambassador 2-6700
Miratile Mfg. Company, Hudson 8-2200
(Serves House Trailer Industry only)
CINCINNATI, OHIO, Wabash 1-4480
Morrison-Drabner Steel Co.
CLEVELAND, OHIO
Copper & Brass Sales, Inc., Endicott 1-6757
Nottingham Steel & Aluminum Company
Phone: Atlantic 1-5100
DALLAS, TEXAS
Delta Metals, Inc., Phone: Logan 7443
Earle M. Jorgensen Co., Riverside 1761
DAVENPORT, IOWA, Phone: 3-1895
Nichols Wire & Aluminum Co.
DETROIT, MICHIGAN
Copper & Brass Sales, Inc., Lorain 7-3380
GRAND RAPIDS, MICHIGAN, Empire 1-6681
Copper & Brass Sales, Inc.
HONOLULU, T. H., Phone: 5-2541
Permanente Cement Co.
HOUSTON, TEXAS
Earle M. Jorgensen Co., Orchard 1621
Standard Brass & Mfg. Co., Capitol 5-6531
INDIANAPOLIS, INDIANA
Hubbell Metals Inc., Phone: Walnut 5-9261
F. H. Langsenkamp Company, Imperial 4321
KANSAS CITY, MISSOURI, Baltimore 1-7760
Hubbell Metals Inc.
LOS ANGELES, CALIFORNIA
Eureka Metals Supply Co., Mutual 7286
Earle M. Jorgensen Co., Lorain 7-1122
Reliance Steel Company, Adams 3-3193
MEMPHIS, TENNESSEE
Hubbell Metals Inc., Phone: 5-2676
MIAMI, FLORIDA, Phone: 84-3165—84-2490
Fullerton Metals Co.
MILWAUKEE, WISCONSIN, Evergreen 4-6000
Korhumel Steel & Aluminum Corp. of Wis.
MINNEAPOLIS, MINNESOTA, Geneva 2661
Korhumel Steel & Aluminum Co.
NEW ORLEANS, LOUISIANA
Orleans Steel Products Co., Inc.
Phone: Raymond 2116
Standard Brass & Mfg. Co., Audubon 1381
NEW YORK METROPOLITAN AREA
T. E. Conklin Brass & Copper Co., Inc.
Phone: Walker 5-7500
A. R. Purdy Company, Inc., Lyndhurst, N. J.
Lyndhurst: Phone Webster 9-8100
New York: Phone Chelsea 3-4455
Newark: Phone Humboldt 2-5566
OAKLAND, CALIFORNIA
American Brass & Copper Co., Higate 4-2366
Gilmore Steel & Supply Co., Glencourt 1-1680
Earle M. Jorgensen Co., Higate 4-2030

Distributor

PHILADELPHIA, PENNSYLVANIA
Hill-Chase & Company, Inc., Delaware 6-5400
PITTSBURGH, PENNSYLVANIA, Churchill 2-3000
William M. Orr Co., Inc.
PORT ARTHUR, TEXAS, Phone: 5-9377
Standard Brass & Mfg. Co.
PORTLAND, OREGON, Phone: Tuxedo 5201
Eagle Metals Inc. of Oregon
SAN FRANCISCO, CALIFORNIA
Gilmore Steel & Supply Co., Klondike 2-0511
SEATTLE, WASHINGTON, Phone: Lander 9974
Eagle Metals Company
SHREVEPORT, LOUISIANA, Phone: 2-9483
Standard Brass & Mfg. Co.
SPOKANE, WASHINGTON, Keystone 0587
Eagle Metals Company
ST. LOUIS, MISSOURI, Phone: Franklin 1-0212
Hubbell Metals Inc.
SYRACUSE, NEW YORK, Syracuse 72-6677
A. R. Purdy Co., Inc.
TULSA, OKLAHOMA, Phone: 85-1511
Earle M. Jorgensen Co.
WATERBURY, CONNECTICUT
Hawkridge Bros. Co., Plaza 6-8121
WICHITA, KANSAS, Amhurst 7-1208—7-1209
General Metals, Inc.

this definition is that it specifies the dripproof enclosure as compared with the "open" enclosure of the general-purpose motor definition. Surveys indicated that at least a dripproof enclosure was required in a high percentage of applications in order to help adequately protect d-c machines, particularly their commutators, when located in the average factory environment.

This new definition was added to the standards in preference to modifying the "general-purpose motor" definition partly because the old definition was still applicable to present day a-c motors without change, and partly because it seemed desirable to infer in the title that these d-c motors were suitable for industrial use but not in the general purpose sense that is associated with squirrel cage induction motors. D-c motors are applied in industry for special purposes.

A "Suggested Standard for Future Design" has been added to the NEMA standards to rate d-c motors 120 and 240 v. This reduces the allowance for line drop to 10 v for the higher voltage systems, which is more than adequate for most applications. It was decided that it would be better to change the standard motor voltages rather than the generator voltages for two reasons. First, if a d-c motor rated 240 v is applied on a 230-volt system, it will run slow, but can easily be speeded up by weakening the field. Secondly, new generators will have to operate in parallel with older 250-v generators in certain instances and must be capable of continuously producing this voltage without over-heating the fields.

The lower voltage of 120 v is standard for motors only up to 10 hp (as most users prefer to go to higher voltage when applying larger ratings); 240 v is standard for all motor ratings above 10 hp.

The NEMA standards have recognized in the past two types of d-c motors: constant speed and adjustable speed. The new standard does not classify the ratings as constant speed and adjustable speed, but groups them all together. The differentiation previously made was rather artificial as the construction of the two types was very similar. It was felt that there was very little demand for constant-

(Continued on page 336)

the POWER
you need
in 1/3 less space...

O-M

CYLINDERS
TIE ROD-LESS

- air and hydraulic
- meet JIC standards

O-M's special interlocking mechanism strips unnecessary bulk, does away with tie rods and out-sized end caps . . . saves up to ⅓ the installation space required by conventional-type cylinders of the same bore.

This internal locking feature means less maintenance, too. O-M cylinders are easier to clean, inspect, remove, disassemble and service, with no alignment problems in re-assembly.

Available in complete range of sizes (1½ to 8" bores), with standard, 2 to 1 or oversize rods. All steel construction with bearing bronze. Completely interchangeable parts. Immediate delivery on many sizes.

Write today for FREE CATALOG!

MAIL COUPON NOW!

ORTMAN-MILLER MACHINE COMPANY
15 143rd Street, Hammond, Indiana
☐ Have representative call
☐ Send latest catalog
Name _____ Position _____
Company _____
Address _____
City _____ Zone ___ State _____

FORD INSTRUMENT

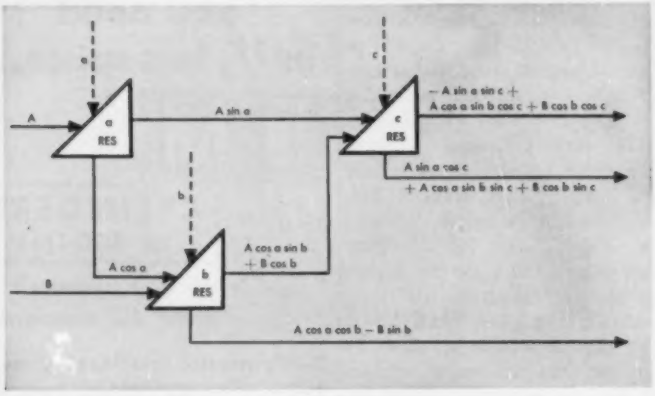
solved one design problem by

CASCADING RESOLVERS WITHOUT ISOLATION AMPLIFIERS

To get around a problem that arises in almost every resolver application Ford engineers recently designed a computer which, among other things, employed a chain of cascaded resolvers to solve complex trigonometric equations, without the use of isolation amplifiers. They solved such an equation as:

$$A \sin a \cos c + A \cos a \sin b \sin c + B \cos b \sin c$$

This was successfully done, without use of vacuum tubes or amplifiers in this circuit:



In view of the widespread use of resolvers to generate sine and cosine functions in modern electro-mechanical analogue computers, it is of great practical significance. Resolvers produced by the Ford Instrument Company have now reached such a high degree of precision, that it is possible to obtain, from an unloaded resolver (which accommodates a single angular quantity only), an accuracy to within less than one tenth of one percent. But most computing circuits call for the use of several resolvers, and once an ordinary resolver is loaded by another resolver, no matter how high its precision, the overall accuracy of the resolver cascade is seriously affected.

The conventional method of avoiding this difficulty is to use an isolation amplifier for each resolver, so that the resolver continues to operate under no-load conditions regardless of the size of the cascade. The importance of cascading without amplifiers is readily appreciated if we realize that the isolation amplifier usually increases the cost of the equipment, more than doubles the size and generates many times more heat that must be dissipated to prevent breakdown of the components. Furthermore, the use of vacuum-tube amplifiers always raises the problem of tube ruggedness and reliability, and requires an additional source of d-c plate voltage.

Have you problems which the engineers at Ford might solve by designing and manufacturing computers, controls or their elements? Write for further information.

85

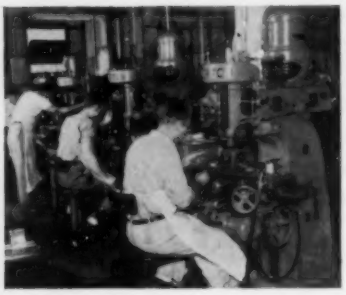
FORD INSTRUMENT COMPANY

Division of Sperry Rand Corporation

31-10 Thomson Ave., Long Island City 1, N. Y.

Ford's capabilities are among the finest in the country

One of the Ford laboratories where a particular design project has called for careful study of resolvers and resolver cascading. Two of the engineers assigned to this project are here checking results. From this work will come one of the new, highly classified weapon systems for the armed forces.

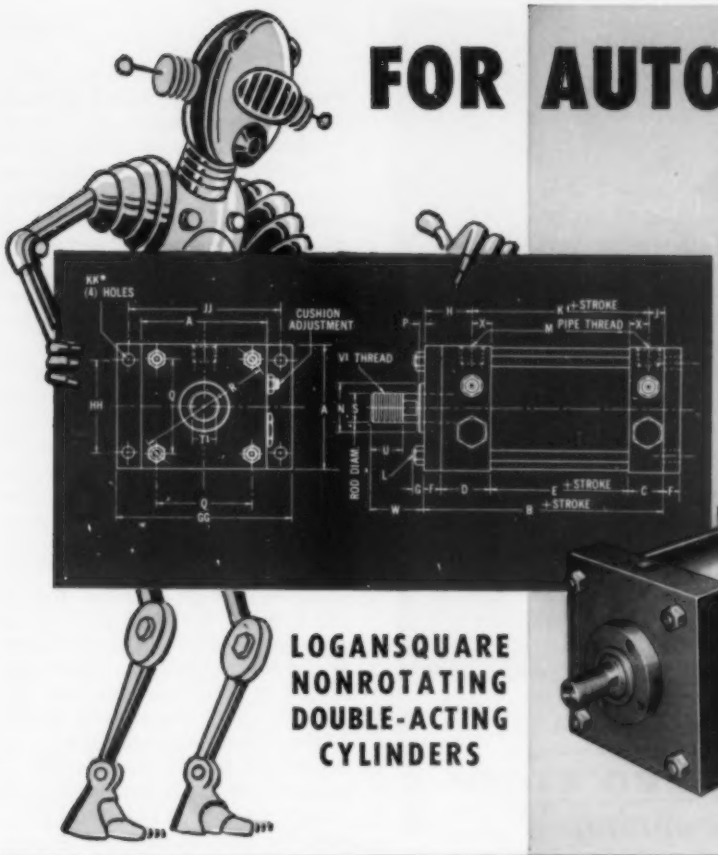


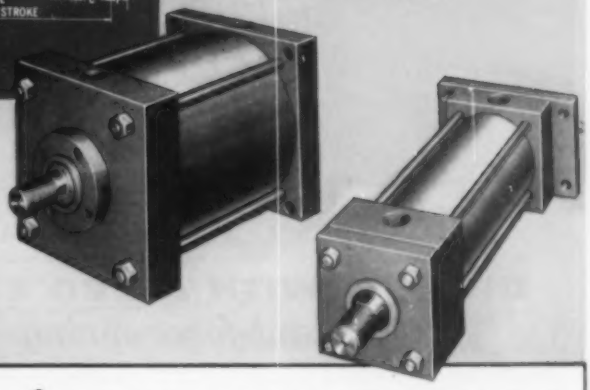
For accuracy and reliability—both vitally necessary in military instruments—experienced machinists must work to fine precision—in the order of .0005 of an inch. Here in one section of the shops of Ford Instrument Company, men are milling parts for an airborne computer.

During the past year Ford Instrument Company has been busy working on many contracts for the U. S. Air Force and the U. S. Navy Bureau of Aeronautics, designing and manufacturing complex computers, controls and their components. For over forty years, Ford Instrument Company has devoted most of its efforts in working for the government to the many problems of weapon controls.

FOR AUTOMATION IT'S Logan

AIR AND HYDRAULIC FLUID POWER EQUIPMENT





LOGANSQUARE NONROTATING DOUBLE-ACTING CYLINDERS

Bore	A	B	C	D	E	F	G	H	J	K	L	M	N +.000 −.003	P	Q ±.005	R	S	T¹	U	V¹	W	X	GG	HH	JJ	KK	AD	AE
1½	2	4	1	1½	1⅜	⅝	⅜	1⅝	⅞	2⅛	⅝-28	⅜	1⅜	⅛	1.458	2⅛	⅝	½	⅝	⅝-18	1⅜	⅛	3⅝	1⅞	2¾	⅛	—	—
2	2½	4	1	1½	1⅜	⅝	⅛	1⅝	⅞	2⅛	⅝-24	⅜	1⅜	⅛	1.856	2⅝	⅝	½	⅝	⅝-18	1⅜	⅛	4⅛	1³¹⁄₃₂	3⅛	⅜	—	—
2½	3	4⅜	1	1½	1⅜	⅝	⅛	1⅝	⅞	2½	⅝-24	⅜	1⅜	⅛	2.209	3⅛	⅝	½	⅝	⅝-18	1⅜	⅛	4⅝	2⅛	3⅝	⅜	—	—
3	3⅝	5	1⅜	1⅜	1⅜	⅝	⅜	1¹¹⁄₁₆	⅝	2⅝	⅝-24	½	1⅜	⅛	2.651	3⅝	1	⅞	1⅛	1-14	1⅞	1⅛	5½	2⅝	4¹¹⁄₁₆	⅞	—	—
4	4½	5⅛	1⅜	1⅜	1⅜	⅝	⅜	1¹¹⁄₁₆	⅝	3	⅝-24	½	1⅜	⅛	3.402	4¹⁵⁄₁₆	1	⅞	1⅛	1-14	1⅞	1⅛	6¼	3¹¹⁄₁₆	5⅞	⅞	—	—
5	5½	5½	1⅜	1⅜	1⅜	⅝	⅛	1¹¹⁄₁₆	⅝	3½	⅞-20	½	2	⅜	4.154	5⅜	1⅜	⅞	1⅜	1-14	1⅞	1¹⁄₁₆	7½	4½	6½	⅝	—	—
6	6½	6⅝	1½	2	2	⅝	½	1¹¹⁄₁₆	1¹⁄₁₆	3½	½-20	¾	2	⅜	4.993	7⅛	1⅝	1⅛	1⅝	1⅜-12	2½	1¹⁄₁₆	8½	4⅝	7⅜	⅝	—	—
8	8½	6¼	1½	2	2	⅝	⅝	1¹¹⁄₁₆	1¹⁄₁₆	3½	⅝-18	¾	2½	⅜	6.452	9⅛	1⅝	1⅜	1⅝	1⅜-12	2½	1¹⁄₁₆	—	7¹³⁄₁₆	—	1¹⁄₁₆	4¼	10¹³⁄₁₆

Dimensions apply to no-stroke assemblies. Pipe thread is American (National) "Dryseal." Dimensions for cushioned and noncushioned are identical. All dimensions are given in inches. *Use bolts 1/16 smaller than "KK" (mounting holes).

Broad selection of mountings and mounting combinations. Pressures up to 150 psi air; up to 500 psi oil.

SAVES TIME — Logan — AIR AND HYDRAULIC EQUIPMENT — EFFORT-MOTION

FREE CATALOGS ON REQUEST

YOUR DEPENDABLE SINGLE SOURCE FOR ALL YOUR AIR AND HYDRAULIC EQUIPMENT

Logan

MEMBER: Natl. Mach. Tool Builders' Assn., Natl. Fluid Power Assn.

PROPERLY DESIGNED — PROPERLY EQUIPPED

LOGANSPORT MACHINE CO., INC.
812 CENTER AVENUE, LOGANSPORT, INDIANA

PLEASE SEND COPY OF CATALOG:

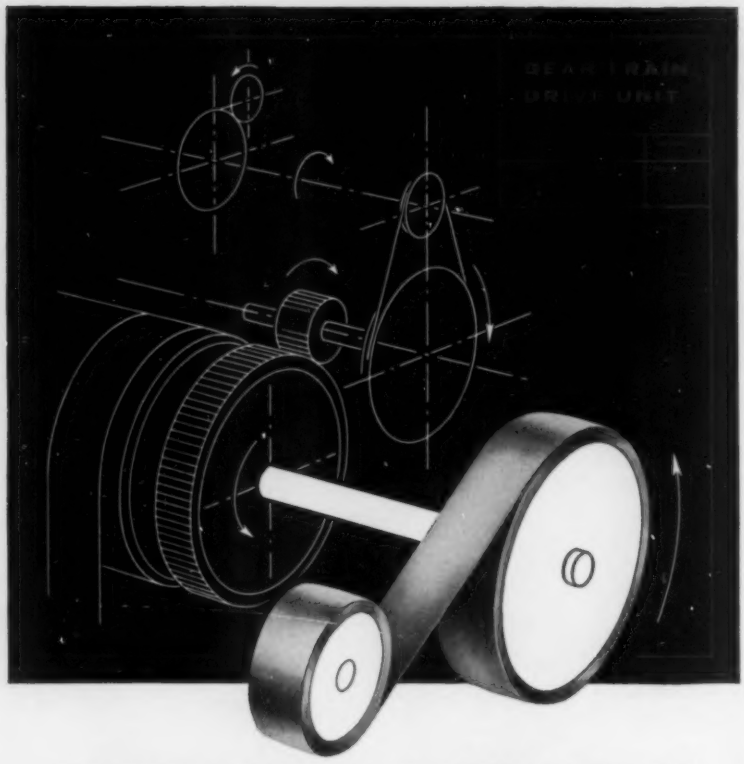
- ☐ 100-1 AIR CYLINDERS
- ☐ 100-2 MILL-TYPE AIR CYLINDERS
- ☐ 100-3 AIR-DRAULIC CYLINDERS
- ☐ 100-4 AIR VALVES
- ☐ 100-5 LOGANSQUARE CYLINDERS
- ☐ 100-5-1 ULTRAMATION CYLINDERS
- ☐ 51 PRESSES
- ☐ FACTS OF LIFE
- ☐ 62 SURE-FLOW PUMPS
- ☐ 200-1 HYD. POWER UNITS
- ☐ 200-2 ROTOCAST HYD. CYLINDERS
- ☐ 200-3 750 SERIES HYD. CYLINDERS
- ☐ 200-4 HYD. VALVES
- ☐ 200-5 FITTINGS
- ☐ 70-1 CHUCKS
- ☐ ABC BOOKLET
- ☐ CIRCUIT RIDER

TO:

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____



DRIVE IT WITH A NEG'ATOR®

constant-force spring

Ideal for use as a powerful, constant-torque motor is the NEG'ATOR Spring, the revolutionary constant-force spring component which is giving design engineers new ideas.

They're using the NEG'ATOR Spring as a motor in two ways. A light torque motor is made by winding the NEG'ATOR Spring around two drums of unequal size. The tendency of the material to recurl to its *preset curvature* around the smaller drum imparts a constant output torque to the shaft of the larger (output) drum. A more powerful and efficient motor is made as shown above—by *reverse*-bending the free end around the output drum.

Think of how products can be improved, problems solved with a long-running, constant-torque motor. An aircraft designer with a critical counterbalance problem found out. So did a manufacturer of self-retrieving, 50-foot, steel tapes . . . a motion picture camera maker . . . an engineer who developed a new precision mechanical computor . . . many others with drive unit, long deflection, and counterbalancing design problems.

And, so will you when you get the full story. Ask us for a copy of Bulletin 310N, "The Story of the NEG'ATOR Spring." We'll send it immediately without cost.

HUNTER SPRING COMPANY

5 Spring Street, Lansdale, Pennsylvania

(near Philadelphia)

SPRINGS • STAMPINGS • TEST APPARATUS

speed motors having a low base speed; therefore the standard motors with low base speed should be designed for adjustable-speed operation. Such motors will also be excellent motors for those few applications where little or no speed range is needed. A precedent had existed in the standards for the combination of constant and adjustable-speed motors in the section pertaining to d-c motors larger than 200 hp, where ratings with low base speed were listed only as adjustable-speed motors. The new standard eliminates many duplications that existed in the old standards, such as 2 hp, 500 rpm base speed which had been listed four times with top speeds of 1000 (constant speed), 1500, 2000 and 3000 rpm (adjustable speed). An attempt has been made to make the new top speed ratings consistent with the inherent mechanical and electrical limitations of the various size motors when all are of similar construction. Because the speed range is not limited to the previous standard values of 3:1, 4:1 and 6:1, there is now more choice in speed range. The maximum speed range is now 4:1. While the old standards allowed ratings of 6:1 speed range, it was felt that motors of this range generally required special construction and their small usage did not warrant listing them as "industrial d-c" machines.

One new base speed rating was added at 2500 rpm. This fits into the previous large gap from 1750 to 3500 rpm. The surveys indicated there was little need for the base speed ratings of d-c motors to correspond to a-c induction motor speeds (only a few applications require interchangeability). The 575-rpm and 690 rpm base speed ratings were combined in a new 650 rpm rating. Base speed ratings of 100, 150, 200, 250, 350, and 450 rpm were dropped. It was felt that below 300 rpm the usage was so small as to take them out of the category of industrial motors. The other ratings dropped were intermediate to ratings retained and the steps between them were closer than necessary, considering the adjustability of d-c motor speed. The steps between adjacent base speed ratings vary from 33 to 52 per cent, as compared with a previous variation of 11 to 100 per cent.

A fresh concept was used in estab-

(Continued on page 357)

lishing the new table of standard d-c generator ratings. The old tables had listed standard kilowatt ratings of ¾, 1, 1½, 2, 3, 5, 7½, 10, 15, 20, 25, 30, 40, 50, 60, 75, 100, 125, 150 and 200 kw. These are the same numbers as used in the motor horsepower tables, and had been arbitrarily chosen as a reasonable series without consideration of their most popular modern usage. This is, according to the surveys, supplying power for adjustable-voltage, d-c motor drives, usually a single motor. With this idea in mind, the power necessary to supply the standard d-c motor ratings was calculated, using typical values of motor efficiency. Also, the output available from standard a-c motors using typical generator efficiencies was calculated. The values chosen were a compromise between the theoretical values obtained by these two methods, and which fortunately satisfy both conditions quite well. The 1.15 service factor of both the a-c motor and the d-c generator can take care of any of the small mismatches.

The standard speed ratings in the old standards included all the 50 and 60-cps synchronous speeds down to 75 rpm and most of the induction motor full-load speeds, for a total of 825 ratings to cover the range of ¾ to 150 kw. Many of the lower speed ratings were seldom used. It was felt that the listing of separate ratings for synchronous and induction motor drives was unnecessary, since in these sizes most d-c generators will be driven by induction motors. If a user drives them instead with a synchronous motor, he will be able to get slightly higher voltage, but there is no disadvantage from such operation.

The tables of standard motor-generator set ratings in Part 13 of the NEMA standards have been revised in accordance with the change in d-c generator ratings.

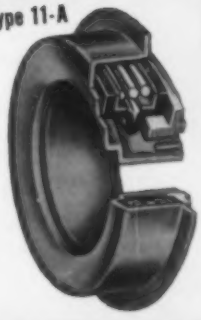
Class B insulation is established in the new standards, with a temperature rise of 60C for the industrial (drip-proof) motors and generators. The previous NEMA standards had long recognized Class B as one of the acceptable groups of insulating materials and had shown the usual temperature rise values to be used with it the same as ASA, AIEE and other standards. These temperature values of 70 C for open machines and 75 C for totally

(Continued on page 340)

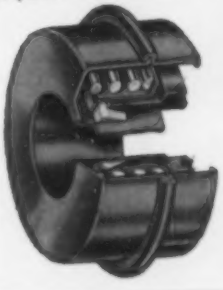
3 JOHN CRANE "Pressed-In" SEALS
for economy, quick installation and life-long performance in all types of service

TYPE 11-A
Synthetic Rubber Bellows • Small shafts to ¾ in.
Services: hot or cold water, oil, gasoline, kerosene and other liquids non-injurious to synthetic rubber.
Pressures: up to 50 psi.
Temperatures: –65°F. to +220°F. Special construction to +300°F.
Construction Data: Packaged unit. Retainer does not contact shaft, permitting operation at a high rpm. One size can be used for several shaft sizes. Bellows encloses spring and metal parts to prevent contact with medium being sealed.

TYPE 6-A
Synthetic Rubber Bellows • Interchangeable with Type 11-A
Services: hot or cold water, oil, gasoline, soapy and other liquids non-injurious to synthetic rubber.
Pressures: up to 75 psi.
Temperatures: –65°F. to +220°F. Special construction to +300°F.
Construction Data: Similar to Type 11-A. Does not contact shaft, permitting operation at high rpm. One size can be used for several shaft sizes. Spring and metal parts available in stainless steel or bronze.



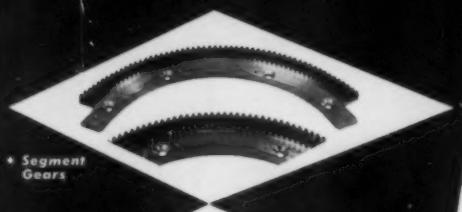
TYPE 9-A
Sealing Members Made of Teflon* • Engineered for the particular application
Services: all chemicals, solvents, oils, corrosives and gases, hot or cold.
Pressures: to 150 psi. Balanced construction to 750 psi.
Temperatures: –120°F. to +500°F.
Construction Data: Packaged unit. Furnished in metallurgical specification best suited to the application. Chemically-inert Teflon wedge ring closely fits inner sleeve of retainer and is machine-mated to carbon sealing washer.



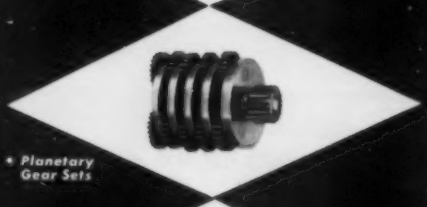
Contact "John Crane" for the particular seal best suited to your application. Request bulletin giving full information on "John Crane's" complete line of mechanical seals.
Crane Packing Co., 6445 Oakton St., Morton Grove, Ill., (Chicago Suburb).
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.
*Du Pont trademark

JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL PROGRESS

Vard maintains a complete gear facility. Vard designs and fabricates gears and gear assemblies to aircraft quality standards in custom or production quantities.

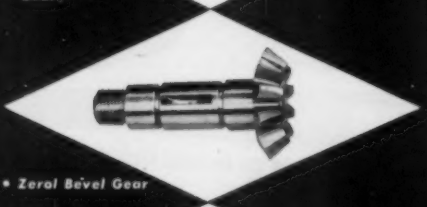


• Segment Gears

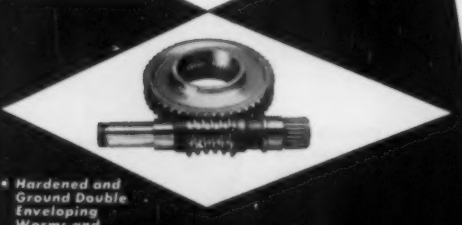


• Planetary Gear Sets

• Constant Acceleration Gears



• Zeral Bevel Gear



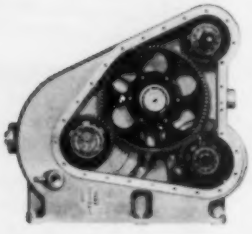
• Hardened and Ground Double Enveloping Worms and Worm Gears

Write for Vard Hardened and Ground Double Enveloping Worm and Worm Gear brochure... Bulletin #1002. Also available is the Vard Custom Products brochure . . . Bulletin #1003.

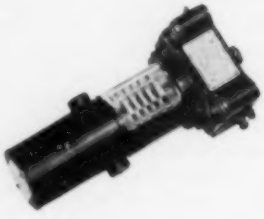
Resident Sales Engineers:
New York City • Dayton, Ohio
Seattle, Washington • Wichita, Kansas

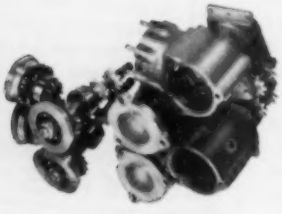
Gears

Alternator — Generator drive gear box manufactured by Vard. Rated at 100 hp at 4000 rpm.

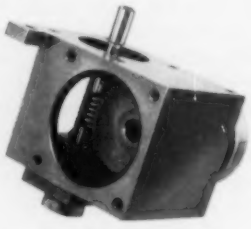


Rotary Actuator developed by Vard. Employs a 6 stage planetary gear system to obtain a reduction of 15,200 to 1.





Gear Train unit which employs a worm gear and mitre bevel gears.



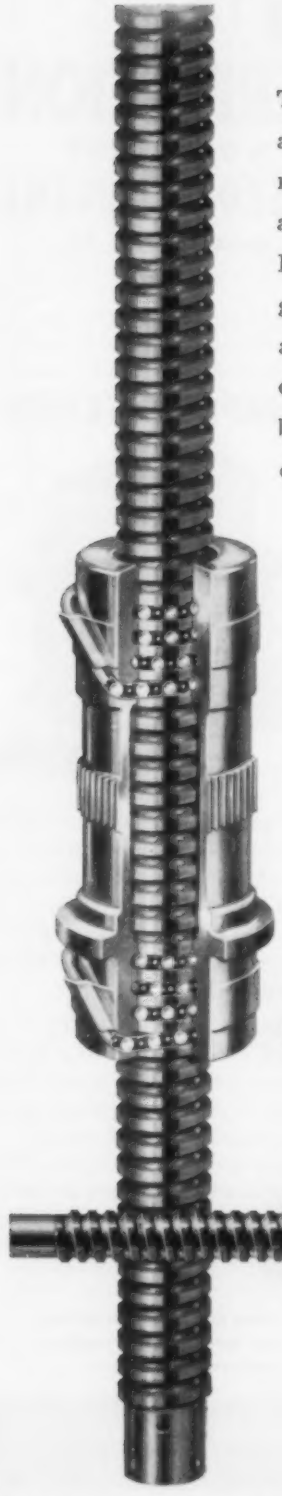
Double Enveloping Worm Gear Box which utilizes a worm that is ground after the hardening process (Rc 60) resulting in zero backlash.

FIRST...in custom gearing

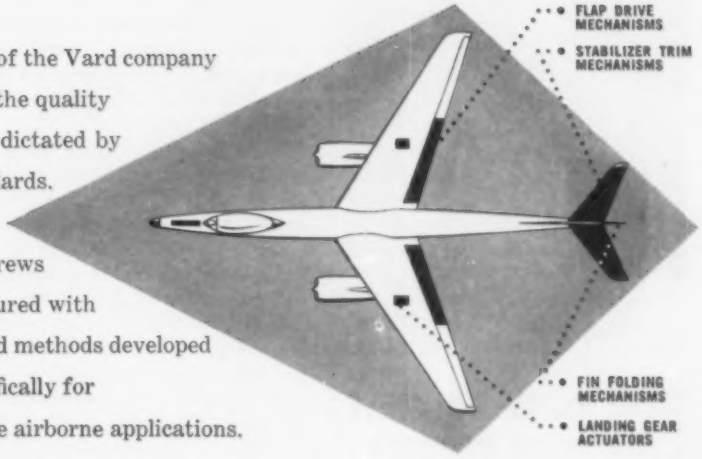
VARD

2981 East Colorado Street
Pasadena 8, California

VARD--FIRST IN MECHANICAL ACTUATION



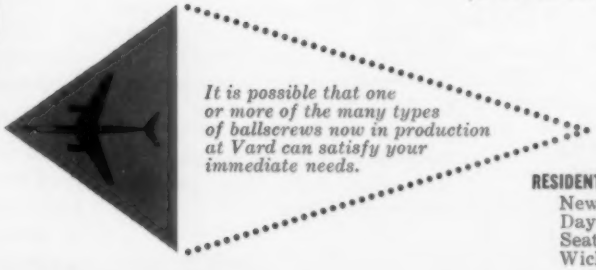
The facilities of the Vard company are geared to the quality requirements dictated by aircraft standards. Production ground ballscrews are manufactured with equipment and methods developed by Vard specifically for close tolerance airborne applications.



In handling your specific problem...

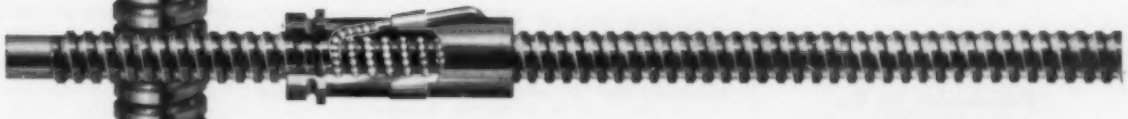
Vard engineers will analyze your ballscrew requirements to determine the advisability of single or multiple ball circuits. Either of these options may utilize all load balls or alternate load and spacer balls.

You may be sure that the combination indicated by our analysis will best meet your needs and will be produced by the finest facilities available.



It is possible that one or more of the many types of ballscrews now in production at Vard can satisfy your immediate needs.

RESIDENT SALES ENGINEERS:
New York City
Dayton, Ohio
Seattle, Washington
Wichita, Kansas



VARD

2981 East Colorado Street
Pasadena 8, California

HOW DOES GARRETT GIVE SUCH SERVICE?

What others may call impossible Garrett comes through as routine service. It seems as though they treat each order as the only one in their three plants. Everybody pitches in for service with the customer in mind.

If it is a stock item such as lock washers, flat washers, spring washers or hose clamps the order is usually on the way the same day. If it is stampings or assemblies Garrett engineers, production men and die makers team up to make their high-speed automatic equipment really hum . . . and your order is in your hands in half the time.

Want to be surprised by real service you can't beat? Next time send your order to Garrett for . . .

LOCK WASHERS
FLAT WASHERS
HOSE CLAMPS
SPRING WASHERS
STAMPINGS

Manufactured by

GEORGE K. GARRETT CO., Inc.
Philadelphia 34, Pa.

Garrett
OF PHILADELPHIA

enclosed machines did not provide for any service factor. The definition of a general-purpose motor describes it as Class A insulated with a 40 C temperature rise. Thus, this new step represents a sharp break with tradition for this type of equipment and a divergence from the present practice of the sister line of general-purpose a-c induction motors.

Class B insulation together with a higher temperature rise results in a smaller machine. This means that less space need be provided for a given rating, that the machine will weigh less, the inertia of the armature will be less, and the response faster.

Considerable development work has been done recently on Class B materials which encouraged the D-C Motor and Generator Subcommittee to choose this class. Of particular interest is the development of wire enamels capable of operating at Class B temperatures. This holds much promise of further reducing the size of machines below that required with glass or asbestos-covered wire.

NEMA standards have frame assignments for most a-c induction motor ratings. Previously there were also frame assignments for d-c motors for the smaller frame sizes; however, it was felt that there was very little need for such standardization and, therefore, no frame assignments for the new ratings are contemplated.

As a result of the changes in rating methods and the higher temperature rise, certain revisions in the standards pertaining to performance characteristics are being made. These have not been completed but do not appear to be seriously different from the old standards. There will be a larger change in the full-load speed of motors (and voltage of generators) during the warming-up period.

Development of a Wire Contact Relay

Abstracted from "Development of a Wire Contact Relay", by R. E. Markle, Associate Member AIEE, Associate Engineer, International Business Machines Corp., Endicott, N. Y.; presented at the AIEE Fall General Meeting, Oct. 3-7, 1955, Chicago, Ill.

The card capacity and life of accounting machines established the required relay switching speeds, as well as the

(Continued on page 341)

PERFECTION
WORM GEAR
SPEED REDUCERS
available in
5
COMPLETE SERIES

Don't go hunting around for Speed Reducers. Your nearest distributor has a complete series of Perfection Speed Reducers with ratios ranging from 5 to 1 to 60 to 1. Furnished with worm on top or bottom as desired.

Shafts are mounted in Timken anti-friction roller bearings. Threads are precision ground and accurately mated with worm gear. Heavy rigid cast iron housings . . . integral worm and shaft. The close limits to which all parts are held, assure maximum load carrying capacity, and long trouble free service.

Write for free 8 page Bulletin No. R-20 listing the complete Perfection Series.

AMERICAN STOCK GEAR DIVISION
Perfection Gear Company • Harvey, Ill., U.S.A.

desired number of operations. An operating time of 4 to 6 millisec, and a release time of 4 millisec is required for this application, while a life of 100 to 200 hundred million operations without adjustments is necessary. In addition, the relay must be compact and operate on low current because of the large number of relays used in a machine. A pluggable construction with a combination of 4, 6, or 12 contacts provides efficient manufacturing and ease of service of both the relay and the machine, with a corresponding overall reduction in costs.

Initial studies indicated that these objectives would be most readily met by the wire spring type of relay. The wires form a micro-contact construction (less than 10 g force) which is inherently simple and inexpensive, and produces relatively high contact pressure with a small force. Furthermore, the small mass of the wire contacts results in very little bounce at high closing speeds. It was found that a wire of the eutectic silver-copper alloy would give both the desirable mechanical and electrical properties. double wires are used to increase contact reliability. To fulfill the "no adjustment" requirement, the relay is designed with sufficient wire flex to compensate for wear and provide adequate contact force even after several hundred million operations. The wires can be easily removed and replaced.

The wires are actuated by an insulating plastic bracket attached to the armature. Wear of the bracket was at first a serious problem because of the constant flexing and sliding of the wires. A non-pigmented urea-formaldehyde resin was eventually found to give the necessary wear resistance.

The original production model, Fig. 1, was designed with a C-shaped molded phenolic-formaldehyde frame to enclose and protect the contacts and minimize the number of parts needed. The fixed contacts of the same eutectic silver-copper alloy are molded into the frame with their ends protruding to make contact with the receptacle. A guide stud is provided to aid in installing, and prevent damage to either receptable or contacts.

The wire contacts are held in position in the relay and forced against the normally-closed contacts by the

(Continued on page 344)

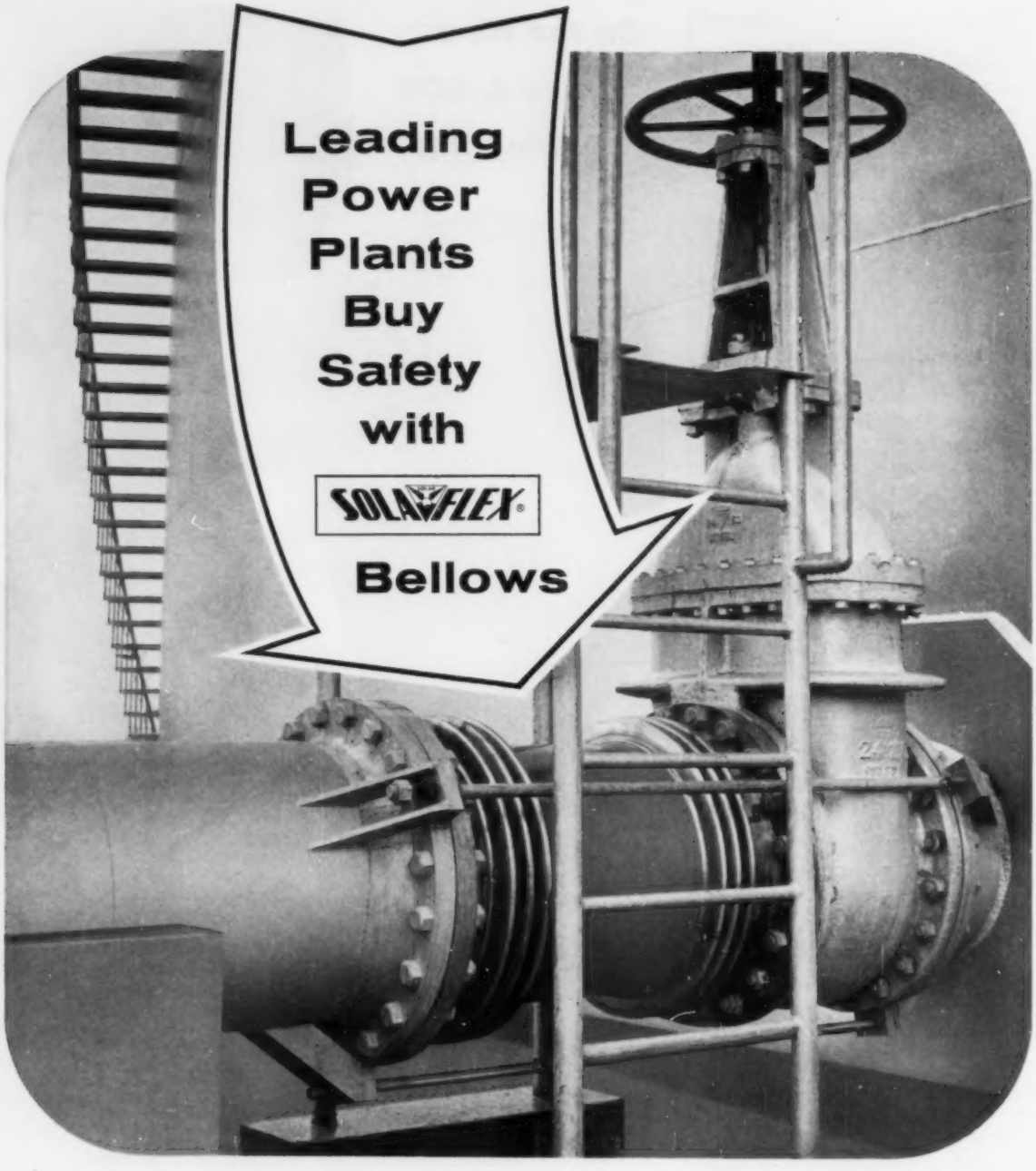
Leading manufacturers find it pays to specify Thermoid Friction Materials. The EMSCO A-800, one of the most advanced drilling rigs in the oil industry, has Thermoid Clutch Facings, custom engineered for smooth, positive engagement and minimum wear. The Brake Linings are Thermoid, too, for extra safety, longer life.

Thermoid can supply you a wide variety of high quality friction materials for all applications—and you get the added benefit of *personalized engineering service*, on orders large or small.

Look to Thermoid, too, for Fan Belts, FHP Belts, Flat Belting, and Hose of any type—to your specifications.

Thermoid

Thermoid Company
Industrial Friction Materials Division
Trenton, New Jersey



SOLA-FLEX EXPANSION JOINTS handle the movement of this big tank and pipeline at one of the Southwest's newest and finest power plants. The 24-inch joint takes axial and lateral offset movement due to changes in pressure, or temperature or to tank shifting. Valve operation is improved, and pipe and tank installations are protected from stresses absorbed by the joint.

Sola-Flex stainless steel bellows with built-in stress rings need no external harness or "strait jacket." The Sola-Flex line meets every piping problem—convoluted for vacuum or low pressure, U-span for medium and high pressure service—in standard pipe sizes and in rectangular shapes also. Send for Sola-Flex catalogs. Address Solar Aircraft Co., Dept. B-108, San Diego 12, Calif.

SOLAR
AIRCRAFT COMPANY
SOLAR
SAN DIEGO DES MOINES

DESIGNERS, DEVELOPERS AND MANUFACTURERS OF METAL ALLOY PRODUCTS · GAS TURBINES · BELLOWS · CONTROLS · HIGH TEMPERATURE COATINGS · AIRCRAFT COMPONENTS

"Here's why we use Harvey Aluminum extrusions in our industrial slides"

Once the manufacturer of this electronic drawer slide machined the three parts from solid bar stock. Now, he uses three *custom designed* Aluminum Extrusions supplied by Harvey Aluminum. They require no machining and need only cutting to length and drilling before final assembly. Production time, scrap loss, handling and over-all costs were all sharply reduced . . . and the product is better, in the bargain. Countless other designs have been simplified and made more profitable by Harvey Aluminum Extrusions. Learn how they can help your own product; send *today* for our brochure, "Aluminum Extrusions."

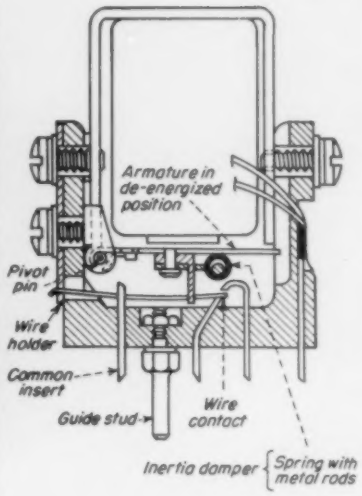
Harvey is a leading independent producer of aluminum extrusions in all alloys and all sizes, special extrusions, press forgings, hollow sections, structurals, rod and bar, forging stock, pipe, tube, impact extrusions, aluminum screw machine products and related products. Also similar products in alloy steel and titanium on application.

Making the most of aluminum ...for everyone

HARVEY Aluminum

HARVEY ALUMINUM SALES, INC.
TORRANCE, CALIFORNIA
Branches in principal cities

Show us
your
blueprint
ON ANY
• industrial part
• consumer item
Gering will show YOU
AN
EXTRUSION
• flexible and rigid plastic
• all sizes, shapes, profiles
The most complete extrusions plant in the world—equipped with 2" to 10" extruders, with dies and take-off equipment to serve ANY need, stock or special—PLUS our helpful engineering and design staff to help solve any blueprint problem. All this backed by our extensive all-over activities in the Thermoplastics field. Quality, small or large quantity, quick delivery.
BELTING
BINDING
GASKETS
RODS
TUBES
FILM
EDGING
Polystyrene • Cellulose Acetate • Vinyl
Ethyl Cellulose • Butyrate (TENITE II)
Polyethylene • Acrylic • Copolymers
Extruded Products Division
GERING
PRODUCTS • INC.
KENILWORTH, N. J.
• SERVICE
• QUALITY
• DEPENDABILITY
BRANCH Offices: Chicago, Ill., Mansfield, Ohio, Cleveland, Ohio, Detroit, Mich.



action of the common inserts, and the wire holder can be adjusted to alter the contact force. The necessary 5 to 8 g force per set of wires is obtained with an 0.016 in. dia wire of 100,000 psi tensile strength.

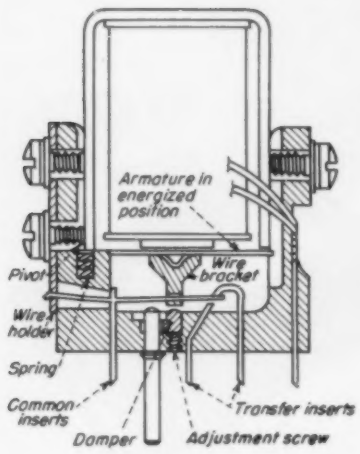
To permit fast release, an 0.004 in. armature-to-core air gap is provided and in addition, a non-magnetic separator of 0.003 in. thick stainless steel is welded on the magnet yoke at the free end of the armature.

After a few years of experience with the original production model, further refinements were incorporated in the design of the present production relay. These changes resulted in a 400 per cent increase in relay life, and a 40 per cent reduction in manufacturing costs.

The present production relay is illustrated in Fig. 2. To increase stability of relay operating characteristics and reduce the air gap tolerances, the armature hinge was converted from a pin-type pivot to a knife-edge design. The use of the knife-edge pivot makes it possible to maintain close tolerances on the armature-to-core air gap during manufacturing, and the increase in bearing surface reduces wear and the subsequent change in release time.

Also, the damping system was modified to prevent armature rebound, which is the primary cause of contact bounce. Since armature rebound during operation caused no contact bounce, it was possible to replace the inertia damper with a soft vinyl stop under the wire bracket. This damping system reduced relay manufacturing

(Continued on page 345)



costs and provided a more stable damper.

In order to eliminate the adhesion of the wire bracket to the vinyl damper caused by the plasticizer at temperatures above 55 C, the damper is made of synthetic elastomer, Buna N.

The final important modification was in the construction of the wire bracket. This part is now molded directly on the armature, replacing a comparatively elaborate riveted assembly. In order to prevent splitting and reduce warping, the bracket is molded in sections, each section containing a mechanical anchor for molding and operating two pairs of contact wires.

The relay is made with double-throw contacts of four, six or twelve poles. A variety of coils are used with as many as three coils on one relay. The release time is less than 4 ms. Normal machine voltage is about 44 v.

The contacts will carry 10 amp steady state current without serious heating, and may be used for short pulses as high as 40 amp. Too high a current produces failure by causing the springs to anneal and burn out. When contacts are used only for carrying current within these limits, relay life is a function of mechanical wear. After 100 to 200 million operations, wear of the contacts, the wire brackets, the common inserts, and the wire holder cause a sufficient loss of contact force to result in unreliable operation. However, when contacts are used to make or interrupt current, relay life will be seriously affected because of

(Continued on page 348)

Special Designs for Special Hydraulic Pump Applications

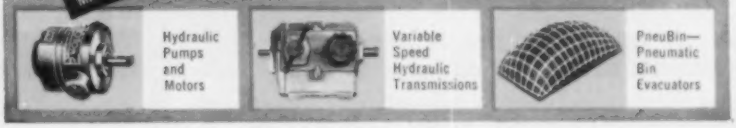
GEROTOR is noted for its precision-built line of standard design pump models, but unheralded, GEROTOR engineers are solving problems at the request of customers who have special design needs.

The precision manufacturing know-how of the GEROTOR organization is available when you have a special design problem. Whether this involves speed, capacity, limited space, mounting, weight or adaption to some peculiar operating condition, a specially designed GEROTOR HYDRAULIC PUMP may solve your problem.

Due to modern facilities, GEROTOR can produce special design pumps in *quantities* on an economical basis. Whatever your hydraulic pump design problem . . . bring it to GEROTOR.

FREE literature available . . . write:

GEROTOR
MAY CORPORATION
MANUFACTURERS OF—
1511 MARYLAND AVENUE, BALTIMORE 3, MARYLAND

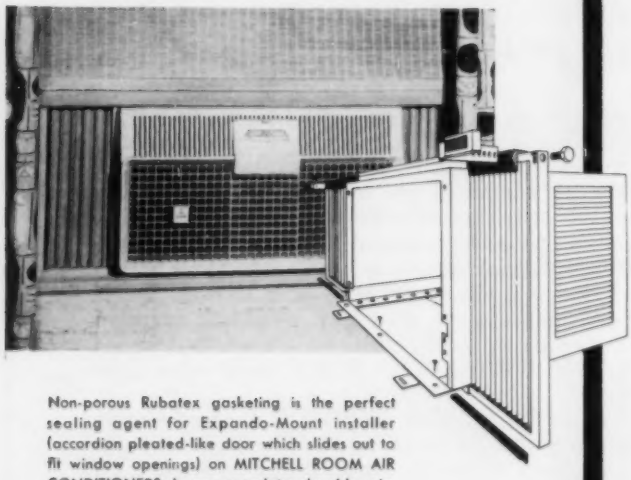


doing unusual jobs unusually well

for 20 years

Layers of Rubatex assure tight effective seal between metal pylon and metal wing surface of CHANCE VOUGHT'S F7U-3 CUTLASS. Also valuable for streamlining purposes and cushions the two metals when pylon is attached to wing of jet fighter.

Rubatex gives air, dust and moisture a technical shut out as an effective non-corrosive seal around door and glass of new U. S. GAUGE PRESSURE PILOT. Dribak adhesive on smooth surface of Rubatex makes application easy and sure.



Non-porous Rubatex gasketing is the perfect sealing agent for Expando-Mount installer (accordion pleated-like door which slides out to fit window openings) on MITCHELL ROOM AIR CONDITIONERS. Insures complete, durable, air-tight, water-tight, dust-tight installation for life of air conditioner.

better performance cheaper

Nitrogen plus natural resiliency of rubber team up in Rubatex to recover quicker than other soft rubber materials after being compressed and to keep coming back for a longer time. Unique closed cellular structure shuts out oxygen, heat, cold, moisture and dirt even at cut edges—eliminates expense for special coating or molded-on skin. No restriction as to shape or size. Can be die cut or stripped. Easily cemented to other materials. Available in soft, medium and firm grades in varying densities and thickness. Write and let us tell you how you can get better gasketing, sealing and cushioning performance cheaper with Rubatex.

PIONEER MANUFACTURER OF CLOSED CELLULAR RUBBER

also manufacturers of:
Rubatex Closed Cellular Vinyl
Rubatex Insulation Hardboard
Rubatex-Crepe
Rubatex Softee-Crepe
Rubatex Vinyl Foam
Rubatex Plastic Seine Floats

GREAT AMERICAN INDUSTRIES, INC.
RUBATEX DIVISION, Bedford, Virginia

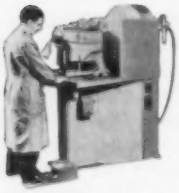
G.A.I. RUBATEX

YOU CAN COMPETE with the biggest on...

- PUNCHING
- NOTCHING
- NIBBLING

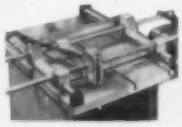
...if you'll Sharpen Your Pencil the "WALES-WAY"

Competition gets a bit rough on big production jobs... particularly when the bid calls for an extra sharp pencil. Some of the big shops, with their modern equipment, plenty of space, ample resources, make it tough for the small shop... UNLESS...



THE WALES FABRICATOR

Yes, there IS an answer to the problem. Give some careful attention to the WALES FABRICATOR... one of the speediest, and most accurate machines ever produced for fast PUNCHING and NOTCHING, for NIBBLING and for every day competitive work.



THE WALES POSITIVE DUPLICATOR

Used with the WALES FABRICATOR, this equipment accurately duplicates holes quickly, easily and without costly dies, plates, attachments and set-up time. Put your Templet in the DUPLICATOR. Put your production piece in the WALES FABRICATOR. Press LOCATOR-PIN of DUPLICATOR gently and a microswitch activates the FABRICATOR. Another 'WALES-WAY' for extra profits.

WALES HOLE PUNCHING UNITS

These Units are self-contained, permitting unlimited patterns without custom built 'fixed' dies for each new pattern. Run one pattern, the same Units may be used with other patterns, over and over again. No dead storage of set-ups. No heavy investment in tooling equipment. Turn out MORE WORK. Bench assembly... reduces press down time. These are but a few of the machines, tools and equipment in the 'WALES-WAY' to bring your shop a step ahead of any competition.

FREE ENGINEERING ANALYSIS

The WALES Engineering staff will be happy to bring the complete story to your shop. They'll survey your work and show you how to save money and make *more profit*. No obligation, of course.

Send for BULLETIN No. 14.

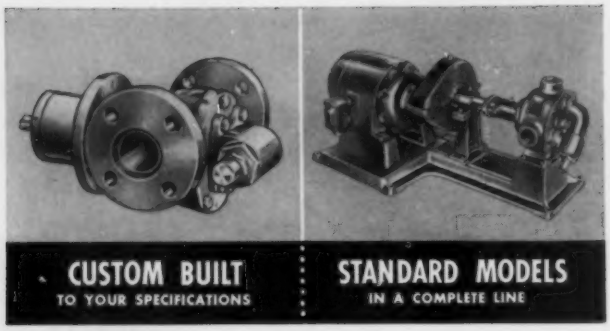
These FOLDERS contain interesting information, descriptions and examples of work done the 'WALES-WAY'

WALES Strippit CORPORATION

"...the Wales-Way is the PLUS-PROFIT way"

345 PAYNE AVE. — North Tonawanda, N.Y.

WALES-STRIPPIT OF CANADA LTD., HAMILTON, ONT.



CUSTOM BUILT
TO YOUR SPECIFICATIONS

STANDARD MODELS
IN A COMPLETE LINE

NEED PUMPS to fit your machine or individual pumping units?

VIKING HAS THEM

Here's how to make sure you have the right pump for each job. Let Viking engineers help you choose. With 750 catalogued models PLUS thousands of special models available, Viking can fit your need. Capacities range from ½ to 1050 gallons per minute.

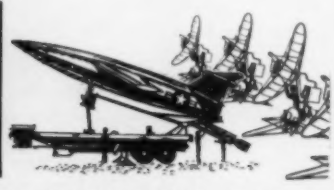
Whether you want to pump a light, highly-volatile liquid or a heavy, semi-solid type, Vikings will give you smooth, positive action. For more information, write for catalog 56Sx today.

VIKING PUMP COMPANY

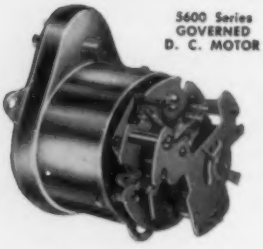
Cedar Falls, Iowa, U.S.A. In Canada, it's "*ROTO-KING*" pumps

See our catalog in Sweets

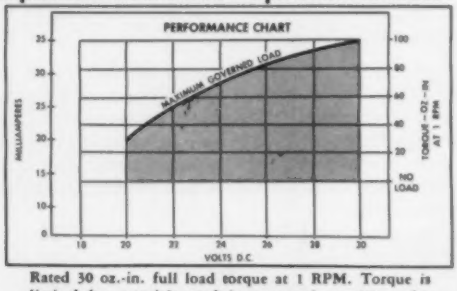
they shall not pass!



A. W. HAYDON PRECISION GOVERNED 5600 SERIES MOTOR insures performance of America's perimeter defenses.



5600 Series GOVERNED D. C. MOTOR



SPECIFICATIONS

1. Voltage range nominal ± 20% at 68°F.
2. Ambient temp. range minus 65°F to plus 165°F.
3. Vibration 5-55 cycles per sec. with 10g max. accel.
4. Tolerance on escapement rate:
   (a) ± 0.1% under condition 1
   (b) ± 0.3% under condition 2
   (c) ± 0.5% under condition 3
5. Shock — per MIL-E-5272A, Proc. 1 (50g for 11ms)

Rated 30 oz.-in. full load torque at 1 RPM. Torque is limited by materials used in gear train to 20 oz.-in. intermittent or 5 oz.-in. continuous duty at 1 RPM. Special gear trains are available.
Output speeds from 900 RPM down to 1 revolution in 2 hours can be provided.

WHEN TIMING POSES A PROBLEM CONSULT . . . .

(General Catalog Sent on Request)

The A. W. HAYDON COMPANY
221 NORTH ELM STREET
WATERBURY 20, CONNECTICUT

Design and Manufacture of Electro-Mechanical Timing Devices

the small mass of the wire contacts.

Relays have been made for circuits in the microampere, millivolt range by a change in contact material, and a modification in the contact design.

The inserts or fixed contacts are fabricated from a thrulay or special raislay construction of a noble alloy of gold, silver, and platinum known as No. 1 metal. The wires are clad with the same material. This use of thrulay and cladding makes it possible to manufacture the relay with no additional costs except for the small amount of precious contact material that is used.

Library Panel Speeds Information

Abstracted from "A Library Panel Speeds the Flow of Information," by William E. Jorgensen, Ch. Librarian, U.S. Navy Electronics Laboratory, San Diego, Calif., Office of Naval Research *Research Reviews*, Oct. 1955.

A technical library battles constantly with its ever-increasing flood of published information. A system has been developed at the library of the U. S. Navy Electronics Laboratory in San Diego, Calif., which reviews and evaluates incoming scientific and technical reports, and in the process lines up names on a priority list for each item. Books and periodicals are not included in this system as the information about them is already accessible through book reviews, abstract journals, indexes, etc.

Members on a literature review panel are selected from the civilian scientists, engineers and technicians in the scientific and technical divisions. Panel members are appointed by their division heads to serve for only three months. The time involved is negligible, for the weekly sessions of the panel last only about an hour or an hour and a half. Members feel they benefit personally by having such convenient access to the whole range of report literature hot off the press.

The panel provides a continuing program for evaluating the current technical literature in terms of its pertinence to laboratory work and for insuring the prompt delivery of new publications to those persons directly concerned. It establishes a mechanism for two-way communication between the library and scientific and technical groups concerning their requirements for published technical in-

(Continued on page 349)

formation. It affords panel members an opportunity to keep abreast of the literature in their fields and to report back to their several groups on the new developments and concepts appearing in the current literature.

The responsibilities of the individual members of the panel are: to review the new technical literature for the purpose of evaluating its pertinence to laboratory work; to indicate if applicable the persons to receive certain publications; and to report back to their own groups new developments and concepts appearing in the publications reviewed.

The final step in the procedure is accomplished when the library staff records the reserve lists for each publication, and starts them all on their circle of short-term loans to those persons indicated by the panel. In the meantime all the scientific and technical personnel in the laboratory are notified of the week's new library accessions by means of a mimeographed acquisitions list. Others who wish to see these publications are added to the reserve lists so they will receive them in turn. The added impetus given by the panel's suggestions for routing have served to increase considerably the use of library materials.

Apparatus Noise Measurement

Abstracted from "Apparatus Noise Measurement" by R. J. Wells, General Electric Co., Schenectady, N. Y.; presented at the AIEE Fall General Meeting, Oct. 3-7, 1955, Chicago, Ill.

Almost all noise measurement techniques and test codes, used for measuring the noise of electrical equipment, are based on the American Standard Test Code for Apparatus Noise Measurement, Z24.7-1950, which is now being revised, a task which will take a year or two to get into print.

The main tasks set by the Z24-W-25 subcommittee working on the revision, are:

1. Procedures for the measurement of total radiated acoustic power.

2. Procedures for the measurement of sound pressure level at specified locations.

3. Consideration of the measurement of impact sounds.

To date, most of the work of this

(Continued on page 351)

Laboratory control over new premix compounds provides GREATER UNIFORMITY OF STRENGTH in Fabricon-molded reinforced plastic parts!

Ever considered the use of reinforced plastic molded parts to *improve* the quality of your product and *reduce* manufacturing costs, too? If so, you'll be *doubly* interested in this latest development from Fabricon. For as pioneers in "gunk molding" of premix compounds, Fabricon chemists and process engineers have been well aware of the lack of uniformity commonly encountered in many such molded parts. That's why, during the past 5-years, they've made it their business to find ways and means of overcoming this obvious limitation. By the selection of proper basic materials to meet specific application requirements. And, too, by the development of special laboratory controlled processing techniques which assure consistent quality in the volume production of intricate, complex parts. As a result, Fabricon's new premix plastic moldings now possess far greater uniformity of strength than heretofore thought possible . . . plus a host of other desirable properties which highly recommend their use on countless different products, *yours included!*

Want more detailed information? Just outline the requirements of your particular application and send them in today!

PHYSICAL CHARACTERISTICS	PREMIX COMPOUND	
	MP-156 (Sisal)	MP-162 (Glass)
Flexural Strength, psi	11,200—13,400	14,000—19,200
Modulus of Elasticity in flexure—10⁶ psi	1.17 — 1.40	1.20 — 1.72
Izod Impact Strength, foot-pounds/inch of notch	4.2 — 8.4	8.3 — 8.3
Water Absorption, % 24 hr.	1.70 Average	0.65 Average
Heat Distortion Temp.	382°F. (+)	382°F. (+)

Above values based upon tests conducted by independent laboratories in accordance with ASTM methods. Compounds listed are latest of over 150 grades developed and produced by Fabricon. Sample test panels gladly furnished upon request.

FABRICON PRODUCTS

A Division of EAGLE-PICHER

1721 W. Pleasant Street
River Rouge 18, Michigan
THE EAGLE-PICHER COMPANY

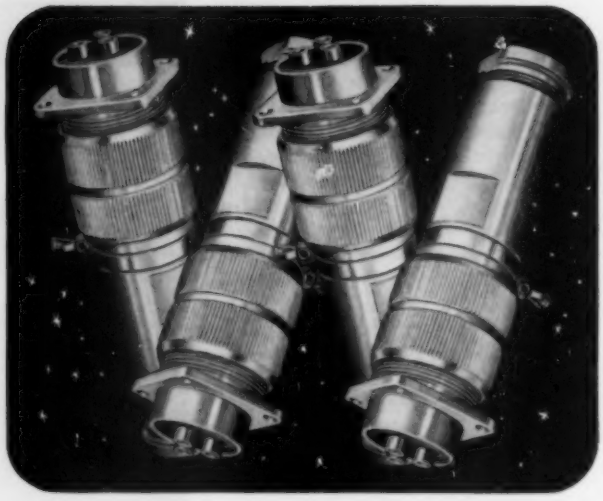
Reinforced Plastic Molded Products • Plastic Impregnated and Coated Materials

For long life under extreme conditions of shock, vibration, corrosion, humidity and temperature

Bendix W TYPE

HEAVY-DUTY

ELECTRICAL CONNECTOR



Intended for use with jacketed cable and not requiring ground return through mating surfaces, this connector incorporates sealing gaskets at all mating joints.

W-Type Bendix* Connectors also incorporate standard Scinflex resilient inserts in established AN contact arrangements. Shell components are thick sectioned high-grade aluminum for maximum strength. All aluminum surfaces are grey anodized for protection against corrosion.

It will pay you to remember that for the really tough jobs, where ordinary electrical connectors just won't do, be sure to specify the W-Type Connector.

Complete specifications and details on request.

*REG. TRADE-MARK

Bendix **SCINTILLA DIVISION of** Bendix AVIATION CORPORATION
SIDNEY, NEW YORK

Export Sales and Service: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

FACTORY BRANCH OFFICES: 117 E. Providencia Avenue, Burbank, California • 512 West Avenue, Jenkintown, Pennsylvania • Stephenson Building, 6560 Cass Avenue, Detroit 2, Michigan • 5006 North Port Washington Road, Milwaukee 17, Wisconsin • American Building, 4 S. Main St., Dayton 2, Ohio • 8401 Cedar Springs Road, Dallas 19, Texas • Boeing Field, Seattle 8, Washington • 1701 "K" Street, N. W., Washington 6, D. C.

printing units

- SHEETS
- BARS
- COIL
- TUBES

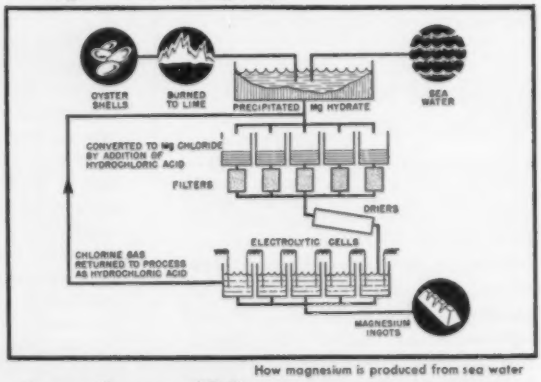
Matthews Printing Units are easily adapted to your production lines for continuous ink marking of trade names, codes, numbers, or other specified identification.

"On-the-line" units mark bars, tubes, sheets, and coils as fast as they are being fed . . . automatically . . . with an ink supply that lasts for hours. Hand-held printers are available for "off-the-line" marking, or where lightweight, portable units are desired.

Write Matthews today for complete information and literature. Include details of your product marking problem.

JAS. H. MATTHEWS & CO.
3956 FORBES ST. PITTSBURGH 13, PA.
BOSTON • CHICAGO • PHILADELPHIA • CLIFTON, N. J.

Light metals design tips



How magnesium is produced from sea water

Inexhaustible source makes magnesium ideal metal

Magnesium, the metal made from sea water, is immune to the supply shortages which industry frequently experiences with other structural materials. If all the magnesium in the sea were to be extracted today it would cover the earth's land area to a depth of six feet. In one square mile of sea water there is 11,500,000,000 pounds of magnesium—more than 30 times the amount used in the peak war year of 1943.

In addition, dolomite and magnesite deposits, a source of magnesium quite as good as sea water, are to be found practically anywhere on the earth's surface.

When you design your parts or products for construction of magnesium you won't have to switch to another metal in the future because of changing import conditions or other economic, political or geological considerations.

Write for our Magnesium Design Handbook.

MAGNESIUM COMPANY OF AMERICA
LIGHT METALS FABRICATION DIVISION • EAST CHICAGO 27, IND.

magcoa

group has been with the measurement of total acoustic power. Only objective measurements are being standardized, though subjective criteria are being studied by other exploratory groups. Also, a separate exploratory group is studying the problem of noise measurements which are hampered by the presence of high velocity airstreams.

Most test codes have been concerned only with the measurement of sound pressure levels at specified locations. Such data are usually inadequate and seldom offer a fair means of comparison of the noise of different types of machines. Slight modifications in a machine may change the sound pressure level at one point by several decibels without appreciably affecting the total radiated power. A sound power specification is a much more fundamental quantity than a sound pressure level. At distances somewhat removed from a machine, the sound level in a given room is almost solely dependent on the sound power output. Also, once the sound power is known, it is possible to compute the sound pressure level—within engineering accuracy—at any specified location in a given enclosure.

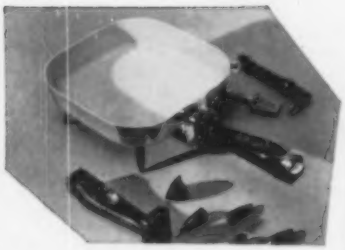
There are several methods of sound power measurement under consideration.

1. *Free Field Measurements.* A space integration of the total sound power radiated into a free field is most basic to sound power measurement. This may be accomplished by a point-by-point survey of the sound pressure over the surface of a hypothetical sphere, or hemisphere, surrounding the device under test. The radius of such a sphere, and the locations of the various microphone positions, are of some importance though they are not highly critical since the same acoustic power must pass through all concentric spheres. In general, the radius chosen should avoid the near sound field—where reactive conditions exist—and the microphone positions should be spaced as uniformly as possible over the surface of the test sphere.

Acoustic directivity increases markedly at the higher frequencies. Hence, a large number of microphone positions may be required to obtain an accurate average for the 4800-9600

(Continued on page 352)

PRODUCT DESIGN WITH DUREZ PHENOLICS



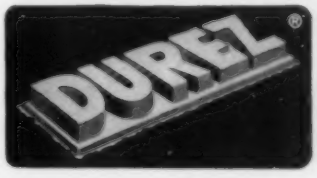
Fry Pan's **HEATER** *is* **CAST-IN**

what can our phenolics help YOU do better?

● Many a trail leading to manufacturing short cuts and better product service is being blazed with Durez phenolics—the basic engineering plastics. One of recent note resulted in this fry pan with its electric unit molded right into the metal casting during the shell molding operation. Casting the metal in shells bonded with Durez resins, this manufacturer reduced assembly and machining operations, saved on labor costs, and practically eliminated spoilage. Then he finished off a superior product with a beautiful jet-black, heat-resistant handle, legs, and cover knob molded of Durez phenolic plastic.

Durez phenolic resins or molding compounds, or both, could help you solve design or production problems that no other material can do so well. Talk with your molder . . . or call on our technical field men.

IF YOU ARE interested in casting by the shell mold process ask for our "Guide to Shell Molding". If you are interested in formed plastic parts, ask for "Facts on Phenolics".



DUREZ PLASTICS DIVISION
HOOKER ELECTROCHEMICAL COMPANY
Phenolic molding materials and phenolic resins that fit the job
HOOKER CHEMICALS
1501 WALCK ROAD, NORTH TONAWANDA, N. Y.

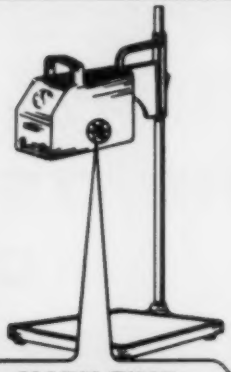
MARK-TIME
helps designers
meet
RIGID
Specifications

Manufacturers with *unusual* timing problems have found that MARK-TIME engineers come up with the answer in quick time. For *your* new designs turn to MARK-TIME, with 25 years of experience in the design and manufacture of timing devices, for the *right* control unit.

MARK-TIME 25th YEAR

M. H. RHODES, INC.
HARTFORD 6, CONNECTICUT

Manufactured and sold in Canada by
SPERRY GYROSCOPE OTTAWA, Limited
3 Hamilton St., Ottawa, Ontario, Canada



MARK-TIME
makes the difference!

Atom-Powered X-ray Unit

A compact Mark-Time timing mechanism controls the radio-active exposure interval of this new light-weight atom-powered X-ray unit. In the Mark-Time unit, the toggle that releases the shutter is constructed as a lock, allowing the timing mechanism to be pre-set and put in operation by a flick of the toggle. Further proof that where precise timing, weight and size are critical, MARK-TIME makes the difference.

MARK-TIME representatives in cities throughout the U.S.

Operating temperature range from −65° to +100° C

International selenium cartridge rectifiers

Designed for long life and dependability, these high voltage cartridge rectifiers contain the most reliable components known to the industry. Completely shock resistant, they are ideally suited for compact, low current applications. 3 types: Phenolic Cartridge; Moisture sealed; Hermetically sealed. Current ratings from 200 microamperes to 100 milliamperes. Output voltage ratings up to 6,000 volts per cartridge.

A WORLD OF DIFFERENCE . . . THROUGH RESEARCH

International Rectifier
CORPORATION
EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281

cps band. One of the basic advantages of the sound power approach to noise specification is the test flexibility in respect to microphone placement. Actually, fixed discrete microphone positions are not required, and the use of automatic rotating devices may be preferable. In tests at General Electric, the noise source is rotated on a turntable while the microphone travels along a 90 deg arc about an axis perpendicular to the turntable axis. As a result, the microphone effectively traverses a spiral path about the noise source. In order to weight the output signal in proportion to the incremental zone of the test sphere, a cosine potentiometer may be employed. An alternative possibility is the use of a cosine drive on the traveling microphone. The microphone signal is fed to an integrating or averaging circuit and then to a meter.

Regardless of what microphone positions are used, the objective is to obtain an average sound pressure level over the chosen test surface. Better still, assuming sound intensity to be proportional to the square of the sound pressure—as it should be in a free field—the average intensity may be obtained with automatic equipment by squaring the signal before averaging it. Given the average sound intensity, the total radiated sound power, in watts, may be obtained simply by multiplying the intensity of the area of the test surface.

2. *Reverberant Field Measurements.* An alternative approach to sound power measurement involves the use of a reverberation room. In a large reverberant enclosure, the sound pressure level due to a given sound source is essentially independent of position. Thus, for any particular reverberant room, the average sound level is determined solely by the acoustic power of the sound source. Hence, assuming that the room is properly calibrated, the sound power being developed by an apparatus may theoretically be obtained from a single sound level measurement. In practice, the sound is never perfectly diffused, so the use of the average sound level for several locations is preferable.

A superior method seems to be the use of a standard source of known sound power output. This procedure

(Continued on page 353)

requires but a minimum of equipment and eliminates what otherwise appears to be a source of systematic error; namely, the existence of increased sound levels near the walls and corners of the room. The known sound power source may be standard machine, the sound power of which has been accurately determined by a free-field integration procedure, or from a test in a calibrated reverberation room such as the Riverbank room or the Bureau of Standards room. An alternative sound source is a loud speaker of high acoustic impedance driven by octave-bands of a monitored electrical noise signal. In either case, the standard source is sounded in the room to be calibrated and the difference between the average sound pressure level and the known sound power level is determined by octave bands.

The accuracy of sound power measurements in a reverberation room is, in general, limited by the degree of sound diffusion within the room and by the constancy of its calibration. The degree of diffusion is a function of the room dimensions and absorption, and the character of the noise itself. For low frequencies a large room is required.

The constancy of the room calibration is dependent upon the constancy of the contents of the room. For this reason, few, if any, people should be permitted within the room during tests. However, an additional source of error is the fact that, at the higher frequencies, a considerable portion of the total absorption in a rather live room is due to molecular absorption in the air itself. Since such absorption varies with the atmospheric conditions, care should be taken to maintain constant conditions of temperature and humidity if high accuracy is required above about 2000 cps.

3. *Semi-Reverberant Field Measurements.* High quality free-field or reverberation rooms are rather expensive test facilities. Many people interested in noise are, therefore, forced to make their measurements in factory or laboratory areas where the walls, etc. are neither acoustically dead nor completely reflecting. In such an enclosure the sound level does not follow the inverse square law—6 db drop per doubling of distance—in the neighborhood of the microphone positions,

(Continued on page 354)

Smooth, durable, flexible joints in belting, aprons, tapes or ribbons are essential to the efficient operation of your machines. You can give your products new sales appeal and your customers important maintenance and operating savings by using Clipper joints.

Clipper belt lacing equipment produces secure, flexible joints in minutes, without injuring belting. It gives smooth joints that ride freely over conveyors or pulleys . . . that are flexible *both* ways of the belt. No other fastening method has *all* these advantages. Use Clipper belt hooks and lacers to put new dependability, serviceability and salability into your product.

WRITE FOR FREE SAMPLE

showing how Clipper fastens belts, aprons, tapes and ribbons into a smooth, flexible joint. Send a sample of your own material for a free lacing.

Ask your Industrial Distributor for Clipper Products

Clipper BELT LACER COMPANY

986 Front Ave., N. W., Grand Rapids 2, Michigan

How Chace Thermostatic Bimetal Actuates

Products of
Stevens Manufacturing Company, Inc.,
Mansfield, Ohio

STEMCO TYPE A THERMOSTATS

Stevens Manufacturing Company produces standard designed thermostats in a wide variety of types to accommodate volume production applications. Stevens-built thermostats are universally recognized for accurate performance and long service life and are to be found in leading makes of household appliances, electronic equipment, industrial control apparatus, etc. — wherever sensitive thermally responsive regulation is required.

One of the many Stevens thermostat designs which employs Chace Thermostatic Bimetal is the Stemco Type A, used to make and break circuit upon temperature change (either increase or decrease), within a range of −40° to +400° F.

In the *make* position, current flows from terminal (1) to terminal (2) through contact spring (3) which is held closed by insulator button (4). Heat from the controlled device is transmitted to the bimetal thermal element by two means: first, by conduction through the metal housing (5) which is in contact with the device; and second, by radiation because bimetal disc (6) is in close proximity to the controlled surface. When preset temperature is reached, the bimetal disc snaps to reverse curvature. Since pressure on the contact spring is released, contacts (7, 8) quickly separate to break the circuit. As temperature drops to a predetermined point, bimetal snaps contacts *closed* again.

Chace Thermostatic Bimetal is available in 29 different types, in strip, coils, or in complete elements fabricated to customer specification. Write now for 36-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing information of value to designers of thermally responsive devices.

W. M. CHACE CO.
Thermostatic Bimetal
1607 BEARD AVE., DETROIT 9, MICH.

as it should in a free-field. Neither is the sound level essentially independent of location as it should be in a truly random or reverberant field. However, measurements must often be made under such conditions.

The recommended procedure is as follows: First, microphone positions that would be satisfactory in a free-field are chosen. Then the noise of a machine is measured by two methods:

(a) In the test room.

(b) In a free-field—perhaps outdoors on a calm, quiet day—with the machine suspended or mounted as in the test room. No reflecting surface, other than the ground should be within 100 feet. The microphone positions should duplicate those used in the test room.

The room coefficient should then be computed for each octave-band.

The sound power level of any machine under test in a room calibrated as indicated above may be determined, and must be computed for each octave-band, and the powers in the various bands should be added to obtain the overall sound power level.

The method outlined has the advantage of requiring no tests, or decisions, regarding the state of the sound field within the test chamber.

Sound power data are probably best presented as a sound power level octave-band spectrum. However, in order to provide a basis of comparison with previous sound pressure level measurements and standards, the data may also be presented as computed free-field average levels at a specified distance. If the machine normally rests on a hard floor, this computation may be made from the hemispherical radiation relation. For a freely suspended machine, or small hand-held device, the spherical radiation relation should be employed.

Sound control criteria are usually specified as octave-band sound pressure levels at the location of interest.

Evaluation of Engineering Education

Abstracted from "Report on Evaluation of Engineering Education," 1952-1955, American Society for Engineering Education, Northwestern University, Evanston, Ill.

Engineering education must contribute to the development of men who can face new and difficult engineering

(Continued on page 357)

MELTING FORGING HEAT TREATING MACHINING

"THE WHOLE BALL OF WAX"

Complete Steel Forging Facilities from Melt to Finished Product for Heavy Press Forgings of Intricate Shape . . . . . Write

Cameron

IRON WORKS, Inc.

SPECIAL PRODUCTS DEPARTMENT
P. O. Box 1212, Houston, Texas

TAYLOR Laminated Plastics Vulcanized Fibre

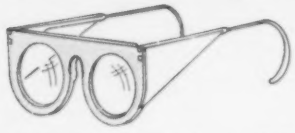
Shop Talk

TAYLOR FIBRE CO.

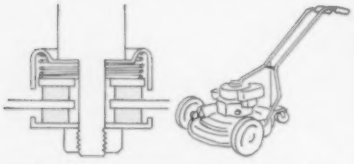
Plants in Norristown, Pa. and La Verne, Calif.

PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD

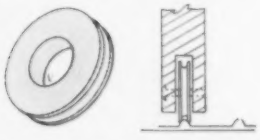
Tips for designers



Frames for industrial eye-glasses, of Taylor Phenolic Laminate . . . are resistant to moisture and acids, possess high physical strength.



Rotary lawn mower utilizes abrasion resistance of Taylor Phenolic Laminate washer in slip-clutch attachment of drive shaft to cutting blade.

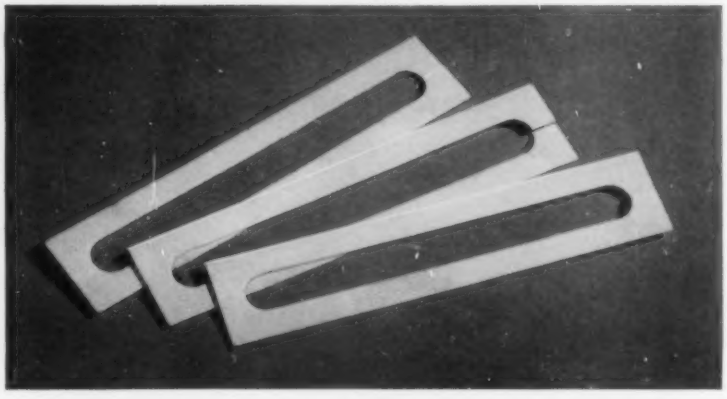


Rollers for flush doors are now being made from Taylor paper base tubing with ball bearing insert . . . providing smooth, silent operation at a low cost.

Automobile clock is securely and economically mounted on inside surface of metal dashboard, with a spacer fabricated from Taylor Vulcanized Fibre.

TAYLOR FABRICATING FACILITIES

Your production problems can often be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts of vulcanized fibre and laminates to your specifications. Efficient, modern facilities are ready to serve you. Write to Taylor about your specific requirements.



Jack & Heintz engineers selected Taylor glass base silicone laminates for dependable insulation of rotor windings in a DC generator for aircraft.

For critical insulation requirements use Taylor glass base laminates

Looking for exactly the right laminate to handle a particularly tough electrical insulation job? You'll find what you need in the many grades of Taylor glass base laminates . . . each using a special formulation of Taylor phenol, melamine, silicone, or epoxy resin. Possessing a broad range of stable insulation qualities and high mechanical strength, these laminates are standard Taylor products rather than "specials" made up at infrequent intervals.

From this group of materials you can select not only the insulation characteristics you need but also any desired combination of: prolonged service at elevated temperatures, resistance to chemical action, retention of physical properties, and low moisture absorption. And they are available in sheets, tubes and rods, in sizes that afford maximum economy of material usage in your manufacturing processes.

Equally important in your consideration of these laminates are the specialized techniques and facilities of Taylor's Fabricating Division . . . capable of producing parts to your own specifications, promptly and economically.

Plan to take advantage of these high-performance laminates in your present products or those which you are now designing. Call on Taylor for a discussion of your specific requirements . . . for glass base laminates and for efficient fabrication service.

situations with imagination and competence. Meeting such situations invariably involves both professional and social responsibilities. Scientifically oriented engineering curricula are essential to achieve these ends and the following means of implementation are recommended:

1. A strengthening of work in the basic sciences, including mathematics, chemistry and physics.

2. The identification and inclusion of six engineering sciences, taught with full use of the basic sciences, as a common core of engineering curricula, although not necessarily composed of common courses.

3. An integrated study of engineering analysis, design, and engineering systems for professional background, planned and carried out to stimulate creative and imaginative thinking, and making full use of the basic and engineering sciences.

4. The inclusion of elective subjects to develop the special talents of individual students, to serve the varied needs of society, and to provide flexibility of opportunity for gifted students.

5. A continuing concentrated effort to strengthen and integrate work in the humanistic and social sciences into engineering programs.

6. An insistence upon the development of a high level performance in the oral, written, and graphic communication of ideas.

7. The encouragement of experiments in all areas of engineering education.

8. The strengthening of graduate programs necessary to supply the needs of the profession, conducted in those institutions that can: provide a specially qualified faculty; attract students of superior ability, and furnish adequate financial and administrative support.

9. Positive steps to insure the maintenance of facilities with the intellectual capacity as well as the professional and scholarly attainments necessary to implement the preceding recommendations. These steps include: well-established recruitment, development and evaluation procedures; favorable intellectual atmosphere, reasonable teaching loads and adequate physical facilities, and salary scales based on the recognition that the required superior faculty can be secured

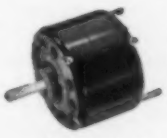
(Continued on page 359)

QUIET as a kitten...!

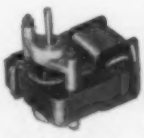
GENERAL INDUSTRIES
Fractional HP. Motors
1/40 HP. to 1/1100 HP.

Quiet Operation, an important factor in most small motor applications, is an outstanding feature of all GENERAL INDUSTRIES FRACTIONAL HP. MOTORS.

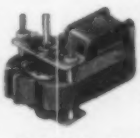
■ Quiet operation, rugged construction, longer life . . . these are the qualities that have become synonymous with General Industries 1/40 HP. to 1/1100 HP. fractional hp. motors. GI motors, backed by over a quarter century of design leadership, are the first choice of manufacturers who have learned to rely on GI. You, too, can have that "extra assurance" of quality performance that comes when you specify GI!



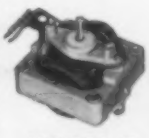
MODEL B
4-pole, 4-coil shaded pole AC Induction Type



MODEL A
2-pole, shaded pole AC Induction Type



MODEL C
2-pole, shaded pole AC Induction Type



MODEL E
4-pole, shaded pole AC Induction Type

MODEL O
2-pole Capacitor Reversible Type AC only (for 6, 12, or 24 volts)

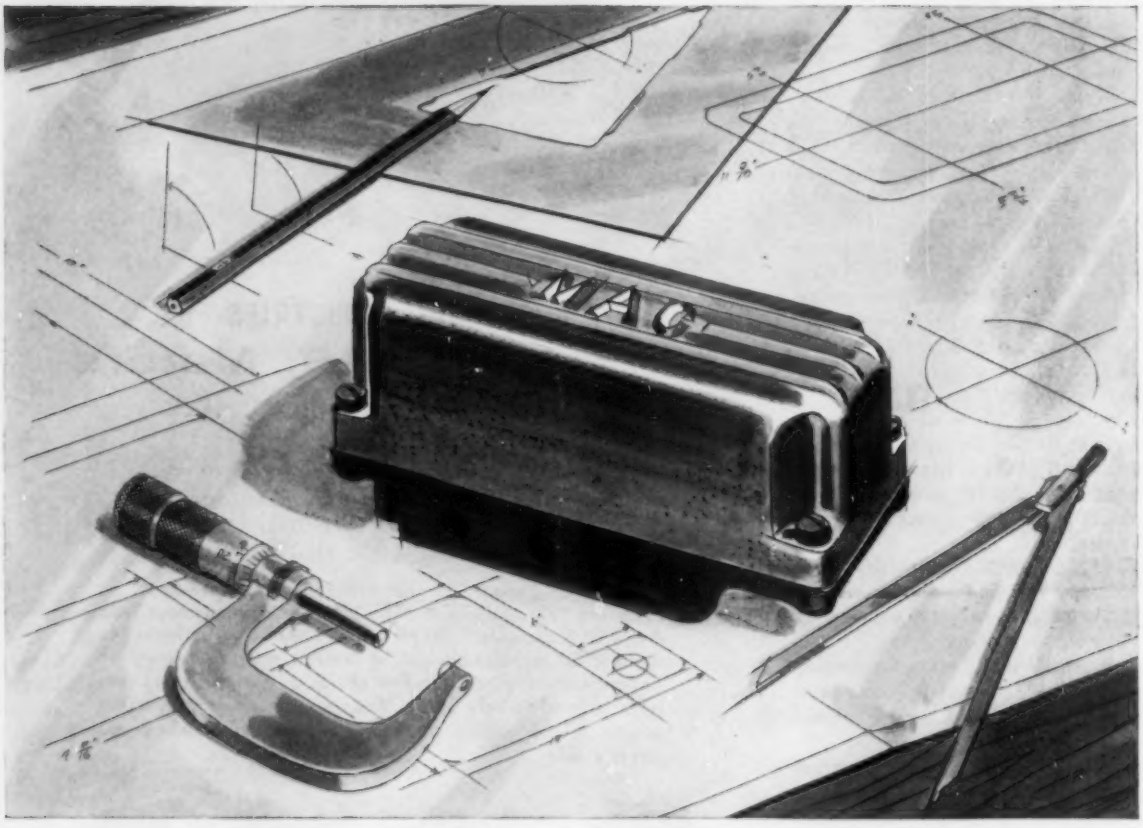
MODEL D
4-pole, 4-coil shaded pole AC Induction Type

MODEL F
2-pole, shaded pole AC Induction Type

Write for Complete Specifications and Quantity - Price Quotations!

THE GENERAL INDUSTRIES CO.
DEPARTMENT GM • ELYRIA, OHIO

WELL CALIBRATED TO KEEP YOU IN OPERATION!



You've seen it happen. An air valve fails—a key piece of equipment goes down—production grinds to a halt. Time, quotas and money are lost, never to be recovered.

But here at MAC we take the downtime out of valves before they leave the plant. Here, where we believe air valves are made more carefully and expertly than anywhere else, every spool, every spring, every solenoid is checked and rechecked. Every valve is tested and retested under conditions as rugged as we can make them. And every valve is *right*, or it doesn't get shipped. Add to this the fact that MAC valves pace the industry for simple, sound design and you'll have an inkling of why MAC has earned a reputation for long, dependable operation for millions of maintenance-free cycles . . . why MAC is well calibrated to keep you operating.

Test a MAC valve in your plant. We have 92 sizes and types—one for virtually any application. Phone a MAC representative, at right, or send for free literature.

MECHANICAL AIR CONTROLS, INC.
10030 Capital, Oak Park, Detroit 37, Michigan

MAC

PHONE YOUR NEARBY "MAC" REPRESENTATIVE FOR DATA AND DELIVERY

CALIFORNIA
OAKLAND 8—The Rucker Co., 4700 San Pablo Ave., OLympic 3-5221
SOUTH GATE—The Rucker Co., 4956 Firestone Blvd., KImball 8271

ILLINOIS
CHICAGO 43—Mike C. Modrich & Co., 10336 South Western Ave., HIlltop 5-3640

INDIANA
FORT WAYNE 3—Neff Engineering Co., P. O. Box 2001, Station A, 2339 Crescent Ave., EAstbrook 7391
INDIANAPOLIS 20—Neff Engineering Co., P.O. Box 7361, 42nd St. Station, BRoadway 2330
SOUTH BEND—Dick Futter, 103 South Varsity Dr., 2-4856

MARYLAND
BALTIMORE 6—Grand Air-Hydro Division, K. William Ostrom & Co., Inc., 6105 Alta Ave., HAmilton 6-6669

MASSACHUSETTS (and New England)
BOSTON 34—Electrical Apparatus Co., Inc., 1200 Soldiers Field Rd., STadium 2-7440

MICHIGAN
BAY CITY—Fred Kober, 506 Chilson St., 2-2629
FLINT—Kober Sales Engineering Co., 514 Beach St., CEdar 8-5123

MINNESOTA
MINNEAPOLIS 4—Air Engineering & Supply Co., 2445 Nicollet Ave., FIlmore 5579
ST. PAUL 14—W. H. Schulz Co., 2438 Franklin Ave., MIdway 2744

MISSOURI
ST. LOUIS COUNTY—Oscar E. Jost Co., P. O. x 6, St. Ann, HArrison 8-4488

NEW JERSEY (Northern)
CRANFORD—The Roden Company, P. O. Box 305, CRanford 6-7330

NEW YORK
BUFFALO 21—C. H. Tepas Co., 200 Washington Hwy., CIrcle 3210

OHIO
CINCINNATI—The R. W. Nichols Co., Fidelity Federal Savings Bldg., 2087-9 Sherman Ave., Norwood, ELmhurst 2440
DAYTON—The R. W. Nichols Co., 407 Realty Bldg., MIchigan 4724
OLMSTED FALLS—The R. W. Nichols Co., P. O. Box 6, BErea 4-1379
YOUNGSTOWN 3—The R. W. Nichols Co., 202 Schwenn-Wagner Bldg., Riverside 4-4550

OREGON
PORTLAND—The Rucker Co., 911 N. W. Hoyt St., BEacon 0205

PENNSYLVANIA
PHILADELPHIA 4—Grand Air-Hydro Div., K. Wm. Ostrom & Co., Inc., 3717 Filbert St., EVergreen 2-5444
PITTSBURGH 22—The R. W. Nichols Co., 101 Investment Bldg., ATlantic 1-6050

TEXAS
DALLAS 19—Womack Machine Supply Co., Shea Rd. at 7200 Harry Hines, DIxon 6997

WASHINGTON
SEATTLE—The Rucker Co., 101 Jones Bldg. Rm. 203, MAin 2783

WISCONSIN
MILWAUKEE 17—Neff Engineering Co., 5856 N. Pt. Washington Rd., EDgewood 2-1579

CANADA
ONTARIO, HAMILTON—Higginson Engineering Sales, P. O. Box 23 (275 James, North), JAckson 9-2262

MECHANICAL AIR CONTROLS, INC.
DETROIT 37, MICHIGAN

MAC

only by competitive remuneration, since professional practice in industry and government is inherently attractive to the best minds in engineering.

10. The consideration of these recommendations before the problems of educating greatly increased numbers of engineers become critical.

Industrial Rotating Hydraulic Drives

Abstracted from "A Search for Controls for Industrial Rotating Hydraulic Drives," by M. G. Malmquist, Supervisor, Instrumentation Dept., Minnesota Mining & Mfg. Co., St. Paul, Minn.; presented at National Conference on Industrial Hydraulics, Chicago, Ill., LaSalle Hotel, Oct., 1955.

When two or more machines are arranged in tandem and are performing operations on a single length or web of material, speed control is of primary importance. Assuming that the first machine operates at a fixed speed, large transient errors are not critical if the web can be permitted to hang loose. A simple speed signal between first and second machines is adequate for satisfactory operation. When more operations on fragile webs are involved, accurate speed control becomes imperative.

Hydraulic and hydraulic-pneumatic control systems offer some interesting possibilities. In the simplest of these, variable displacement pumps are used to drive fixed displacement motors on each machine. Slide blocks on the pumps are positioned by hydraulic cylinders. The cylinder is piped into a line between small variable delivery pumps used as tachometers and driven by the machines. If both tachometers are driven so that they pump the same volume, the piston in the control cylinder remains stationary. Differences in pumped flow result in equivalent differences in the piston position and the second machine speed is adjusted accordingly. This drive is being used successfully.

The limitations in this drive are as follows: Transient errors are cumulative. A strong or stiff web can overdrive the upstream machine creating the possibility of a runaway. Leakage losses in the tachometers are cumulative. A more complex arrangement is possible eliminating some of these faults at the expense of an additional

(Continued on page 360)

CHROMALOX
Electric
TUBULAR HEATERS

provide controlled and dependable conduction, convection or radiant heat

These versatile Chromalox Tubular Heaters provide the kind of heat you need, exactly fitted to your specific heating application.

Available in straight lengths or formed to any desired shape. Used for heating dies, molds, platens; as immersion heaters in liquids, soft metal and molten salts; or in ovens, air ducts and other air heating applications.

Let the Chromalox Sales Engineering staff solve your heating problems . . . electrically

Write for your copy of Catalog 50

—for full information on the complete line of Chromalox Electric Heaters and controls.

For ideas on additional applications of electric heat, request Booklet F1550—"101 Ways to Apply Electric Heat."

Edwin L. Wiegand Company
7535 Thomas Boulevard, Pittsburgh 8, Pennsylvania

EDWIN L. WIEGAND COMPANY
7535 Thomas Boulevard, Pittsburgh 8, Pa.

I would like to have . . .

☐ a copy of Catalog 50
☐ a copy of "101 Ways"
☐ a Sales Engineer contact me.

Name _____
Company _____
Street _____
City _____ Zone _____ State _____

A-4466A

UNIFORM QUALITY
DIVERSE
APPLICATIONS

Each part of every Curtis Universal Joint is made of specially selected steel, individually heat-treated for a specific purpose. This care in manufacture is reflected in our catalog torque and load ratings — which are substantiated by constant testing of production joints.

That's why Curtis Joints are the most dependable, durable and trouble-free available—the standard of the industry.

CURTIS UNIVERSAL JOINTS

- 14 sizes always in stock — bored or unbored hubs
- Fewer parts, simpler construction
- Complete equipment for government tests

PLUS — facilities and engineering skill to handle special specification jobs at any time.

Not sold through distributors. Write direct for free engineering data and price list.

TRADE MARK **CURTIS**

UNIVERSAL JOINT CO., INC.

11 BIRNIE AVENUE, SPRINGFIELD, MASS.

As near to you as your telephone

A MANUFACTURER OF
UNIVERSAL JOINTS SINCE 1919

pump-motor combination at each machine for speed control.

Dancer rolls may be used for speed control of a flexible web. A linkage attached to the roll either operates the pilot of a hydraulic positioning device directly, or through a reset control. Torque control drives are also possible, but these create problems of instability in the systems and they are not applicable if a large percentage of the torque supplied by the hydraulic motor is consumed by the machine.

Pneumatic systems may be used to control hydraulic drives in a similar way, although their slower response limits high performance application.

The day will soon come when an engineer can choose a hydraulic drive and suitable control system from catalogs, install them with confidence, and then merely adjust the dials to bring the system to stability.

Reinforced Plastics From Cellulose Fibers

Abstracted from "Reinforced Plastic From Cellulose Fibres," *Plastics*, Oct. 1955.

New class of materials for low pressure molding are being developed in England by ingenious combinations of papermaking and plastic molding processes. Cellulose pulp is prepared by usual methods in a beater, whereas in the last operation a modified synthetic resin and pigments or dies are added.

This slurry is transferred to a tank and diluted to a solids content of about 2 per cent, and agitated with compressed air. A preform mold with a perforated surface is immersed and a vacuum line is attached to draw fibers to the mold surface. When the coating reaches the desired thickness, the mold is withdrawn and the preform removed. After drying, the preform has a resin content of 15 to 40 per cent. Preforms are then molded by conventional methods, except for an added opening of mold during cure to release surplus moisture.

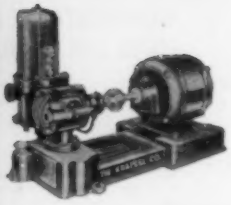
Advantages are low-cost raw materials and preform fabrication, particularly with larger parts such as luggage, radio and television cabinets, trays and tote boxes. Curing cycles are faster and molding pressure is lower since the resin is already distributed.

KRAISSL

Since 1926. In the application, design and manufacture—pumps, separators, hydraulic accessories

EQUIPMENT FOR FLUID POWER TRANSMISSION

Primary Oil Pumps • Vacuum Powered Transmission and Low Pressure Air Service • Air and Liquid Filters •



Rotary Air Pumps for vacuum bottling

Kraissl's patented, automatic, force-free lubrication and flushing system makes these direct - drive, high-capacity pumps ideal for the special requirements of bottle-filling machinery.

Air - cooled design — or water - cooled models for heavier duty.

Class 21-roller-action pumps are recommended for handling corrosive gases and extraneous matter that might jam with closer clearances. The multi-blade design of the Class 25 pumps gives higher capacity efficiencies and is designed for applications requiring higher degree of vacuum. Where water - cooling is desired for continuous service, the water-jacketed Class 25-WJ models are recommended.

EXCLUSIVE CLASS 26 AIR FILTER

is available as an integral part of each pump up to 10 cfm — to produce oil-free discharge air and also conserve the lubricating oil.

Write today for Bulletins A-1289 and A-1523

KRAISSL CO. Inc.

280 Williams Ave., Hackensack, N. J.

NEW BOOKS

Modern Manufacturing Processes

J. L. MORRIS, Assoc. Prof. of Mech. Engrg., Georgia Institute of Technology, 8½ x 5½ in., 533 pp. Published by Prentice-Hall, Inc., Englewood Cliffs, N. J. $9.35.

Well-written, easily read basic text on metal and plastic production and forming. Also included are descriptions of standard tests for engineering materials, information on heat treatment and joining methods and familiarization details of common machine and pressroom tools.

This book will not substitute for a design handbook; rather, it is recommended primarily for orienting those who have design responsibilities but little working knowledge of manufacturing processes.

Die Design Handbook

FRANK M. WILSON, *Editor-in-Chief*. 9 x 6 in., 2150 pp. Published by McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y. $14.50.

Although written principally for die designers, this book is a valuable reference guide for parts designers as well. By designing parts to facilitate tooling, the cycle from design to production is stepped up and costs are reduced.

Material for this handbook has been drawn from technical resources of the American Society of Tool Engineers and many companies that make and use dies, and represents the best in die design practice.

The handbook committee realized that die design cannot stand alone in a really useful handbook, and have therefore related die design in an orderly way to the design of the part to be produced, to the properties of die and stampings materials, to the optimum processing available, to the components that can better be purchased, and to the available pressroom facilities.

There is valuable information on

(Continued on page 363)

an ACCO product

Helicoid Gages

Why HELICOID is the Quality Gage for every pressure indicating service

Acaloy Case Helicoid Gage
Suitable for tap water, steam, inert gases, oils, coal gas and many chemicals.

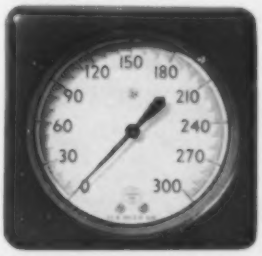
Built RIGHT

Exclusive HELICOID gearless movement. Bourdon tubes of maximum endurance life. Gives highest degree of *sustained accuracy*.

Helicoid Chemical Gage
Suitable for chemicals and other viscous liquids which might corrode or clog Bourdon tube.

Stay RIGHT

No gear teeth to wear out. Convenient external pointer adjustment. Protected from sudden overpressure or pressure reduction.



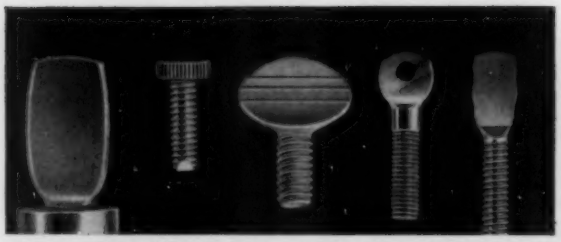
Acaloy Square Flush Case
This is a weather-proof case and ideal for use in symmetrical panels.

Sold RIGHT

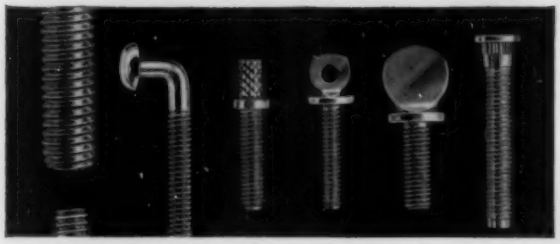
Experienced HELICOID gage engineers are available to help you choose the gage you need. Distributors are conveniently located. Write for the name of the one nearest you.

ACCO
Helicoid Gage Division
AMERICAN CHAIN & CABLE
929-D Connecticut Avenue • Bridgeport 2, Connecticut

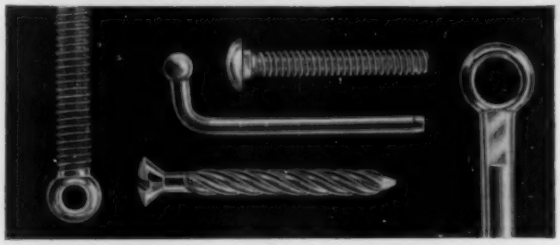
for Better Value



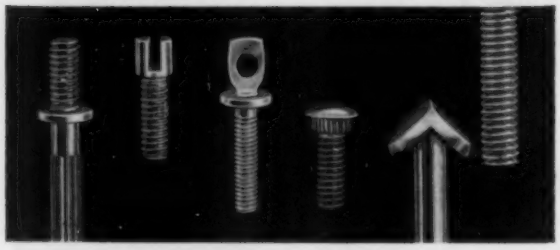
YOU CAN'T BEAT COLD FORMING



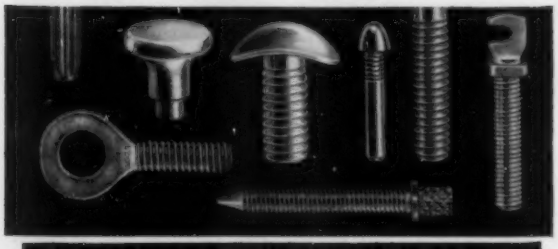
FOR PARTS LIKE THESE—AND



YOU CAN'T BEAT PROGRESSIVE



FOR COLD FORMING . . .

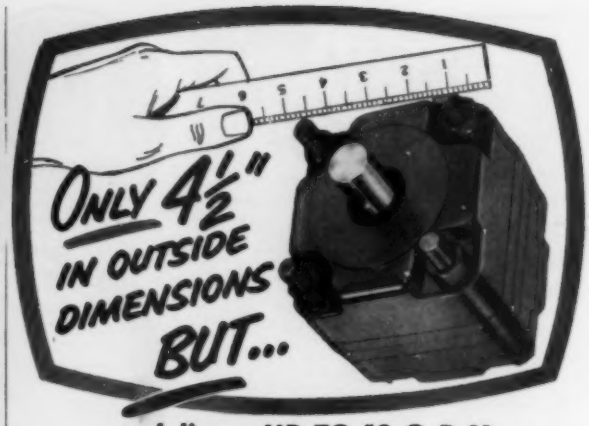


MACHINE SCREWS AND SPECIAL FASTENERS ARE OUR BUSINESS
. . . INCLUDING SQUARE AND HEXAGON MACHINE SCREW NUTS

WRITE FOR OUR CATALOG

THE PROGRESSIVE MANUFACTURING COMPANY

48 NORWOOD ST., TORRINGTON, CONN.



delivers UP TO 12 G.P.M.

CHAR-LYNN 400 PUMP

UP TO 1500 P.S.I.
UP TO 2100 R.P.M.

This hydraulic pump is REVERSIBLE WITHOUT ALTERATION. The ⅜" dia. shaft (with ⅜" key) is housed in Anti-Friction bearings. The hardened steel precision gears (GEROTOR TYPE) are enclosed within an alloyed Die Cast Aluminum body. Mounting is directly on studs which can be reversed for mounting off back of pump. ¼" N.P.T. oil ports.

Write for FREE Catalog

CHAR-LYNN CO.

2843 26th Ave. So., Dept. PE1 Minneapolis 6, Minn.

Member — National Fluid Power Association

Char-Lynn

BROWNING FHP SHEAVES

the most extensive line on the market!

Only Browning offers you all three kinds of sheaves: **Die Cast** for light duty, low initial cost. **Pressed Steel** for sturdy, rugged service at medium price. And **Cast Iron** for heavy duty, highest quality, greatest value; with fixed bore or Browning's famous interchangeable split taper bushing. Choose the sheave most efficient and economical for your every job from Browning's complete range of stock sizes.

Ask your Browning distributor or write us for Catalog V147.

Browning MANUFACTURING COMPANY
MAYSVILLE, KENTUCKY

stampings design, die sets and components, press feeding and unloading equipment, and die and stamping materials.

Information is included on properties and pressworking of new and difficult materials, including titanium, zirconium, and tantalum, on cold extrusion of steel, and on dies, presses, and operations for the hydraulic-action and rubber-action forming methods.

Bibliographic Survey of Corrosion 1950-1951

8½ x 11 in., 430 pp. *Published by the National Assn. of Corrosion Engineers, 1061 M & M Bldg., Houston 2, Texas. Non-members NACE*—$12.50; *members NACE*—$10.

Summaries of 4454 corrosion and corrosion prevention articles, books and brochures published in 1950-1951 are compiled in this volume. Bulletins published by 30 abstracting agencies were canvassed regularly for material taken from more than 500 sources the world over. Literature is listed in eight main groups in the NACE system; general, testing, characteristic corrosion phenomena, corrosive environments, preventive measures, materials of construction, equipment, industries.

Handbook of Engineering Materials

Douglas F. Miner, A. B., B. S., E. E., D.Eng. and John B. Seastone, B.S. 5⅞ x 8⅜ in., 1382 pp. *Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.* $17.50.

Behind this work lies the observation that the conventional, specialized materials handbook no longer serves the engineer efficiently. Increasingly, the various branches of engineering are turning to one another for new materials and processes: the electrical engineer needs data on plastics; the chemical engineer is concerned with the electrical properties of certain materials; the mechanical engineer seeks information on the properties of a new alloy developed in the aeronautics field. This handbook was designed to meet this situation.

The scope of the volume is practi-

(Continued on page 364)

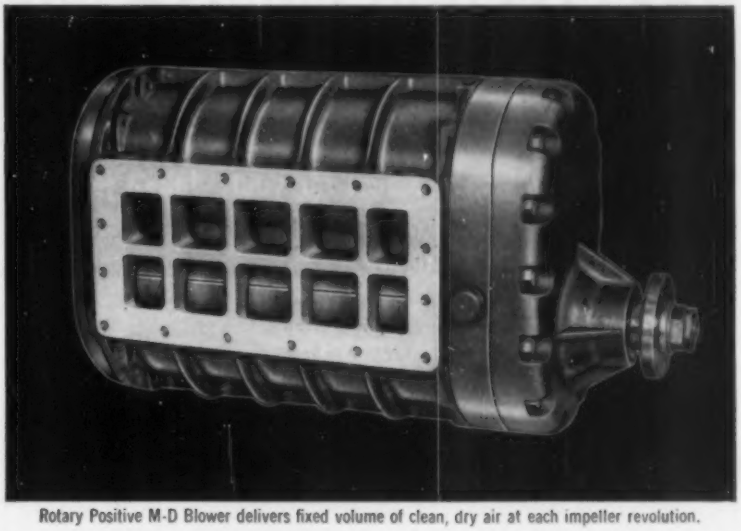
Unique Design Develops New Uses for Miehle-Dexter Blowers

Exclusive three-lobe construction allows pressures up to 14 psig., without increasing size, weight or cost

AS SIMPLE AS IT IS, three-lobe construction represents a tremendous asset to many of our customers. It allows engineers to fit these blowers in their designs with a minimum of space and weight, still achieving pressures as high as 14 psig. from a standard unit.

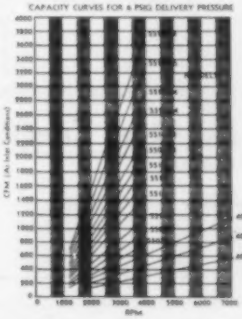
DESIGNERS LIKE two additional exclusive features of the M-D Blower. These features practically eliminate service worries, provide savings in operating and maintenance costs:

1. Patented rubber-grid seals are vulcanized to end plates to eliminate metal-to-metal contact, reducing wear and extending service life.
2. Formica wear strips are rolled into tips of rotor lobes, permitting practically zero clearance between lobes and housing.



Rotary Positive M-D Blower delivers fixed volume of clean, dry air at each impeller revolution.

THAT'S WHY THE AIRCRAFT INDUSTRY developed a new use for Miehle-Dexter Blowers. There, powerful jet engines require mobile ground power equipment. The need is for air to start these engines, air with the velocity of a super-hurricane. Most manufacturers of ground power equipment now specify Miehle-Dexter Positive Displacement Blowers for their equipment.



Typical capacity curve for 6 psig. delivery pressure. Standard sizes available to 4000 cfm. Pressures to 14 psig. (60 psig. by multi-staging) Vacuum to 15" hg.

MIEHLE-DEXTER BLOWERS are versatile, providing air or gas for hundreds of applications. Used in oil fields and on air fields, on processing and compressing equipment. Typical uses are for agitation, aeration, cooling, ventilating, pneumatic conveying, vacuum cleaning. Thousands used as superchargers on diesel and gasoline engines.

LET MIEHLE-DEXTER PROVE how M-D Blowers simplify operations, save weight and space, require little or no maintenance, and reduce costs. Write for Bulletin No. 255.

MIEHLE md DEXTER
Supercharger Division
Dexter Folder Company
111 Fourth St., Racine, Wisconsin

Presteel ingenuity can help YOU!

You can count on Presteel for your "tough jobs."

MASSEY-HARRIS-FERGUSON LTD.

After an extensive vendor survey through the U.S. and Canada, Massey-Harris-Ferguson Limited of Toronto came to Presteel with a pressing problem:

They had just designed the first all-stainless-steel cream separator. The advantages of stainless steel — cleanliness, appearance, long life — were obvious.

Equally obvious was the difficulty of producing the Milk Supply Tank, largest single part of the Separator. Measuring 23¾" x 13½" x 5⅞" deep, the tank has an in-formed flange — notoriously hard to curl smoothly. Now you may think of a separate splash guard welded on, but this offers a cranny custom built for bacteria. If at all possible, the flange had to be integral with the tank. Could Presteel do it? When flange machine makers said it couldn't be done, we stuck to our specialty, press tooling. We added local annealing leaving the top soft and the sides too stiff to buckle.

Result? Results! We are drawing the flange curving inward as pretty as an ocean ripple. Costs were far below estimates for two-piece construction. Give Presteel a crack at your toughest stamping problem. The harder it is, the better we'll like it! Simply send the coupon in today.

Your part has a precedent at Presteel.

Worcester Pressed Steel Company
700 Barber Ave., Worcester 6, Mass.

Please ask your representative to call. ☐
Please send newest brochure. ☐

Name_____
Title_____ Company_____
Street_____
City_____ Zone_____ State_____

cal. More complete than any technical dictionary, it is less exhaustive in given areas than special textbooks. Its aim is to give the engineer maximum help in the selection and use of materials. To this end, it covers only relevant aspects—properties, adaptability to fabricating methods, availability, costs and limitations. Historical background and methods of manufacture are minimized. At the same time, the work offers hundreds of literature references and indicates sources—trade associations, manufacturers—where complete information can be obtained.

The material in this new handbook is presented by classes of related or similar materials rather than alphabetically. Emphasis is on numerical data, presented where possible in tabular or graphic form.

Businessman's Guide to Government Information and Advice

Edited by Sherman S. Cohen, *V.P., General Counsel, American Assn. for Public Information, Education and Research, 5x8½ in., 97 pp, paperbound; published by American Assn. for Public Information, Education and Research, 1010 Vermont Ave., N. W., Washington 5, D.C. $1.*

Designed as a guide to current government information and advice, the booklet contains an annotated bibliography of publications on banking and finance, foreign trade, government management, labor relations, domestic commerce, small business management, public administration and transportation. It also contains a directory of key federal personnel who deal with the collecting and analysis of government information.

Machine Design

Paul H. Black, *Prof. of Mech. Engrg., Ohio University, 6 x 9 in., 471 pp. Published by McGraw-Hill Book Co., Inc. 330 W. 42 St., New York 36, N. Y. $7.50.*

The emphasis in this thoroughly revised second edition is on practical design applications rather than academic analysis problems. It acknowledges that the trend today is to design

(Continued on page 366)

Potter & Brumfield

RELAYS

Reduce Assembly Costs!

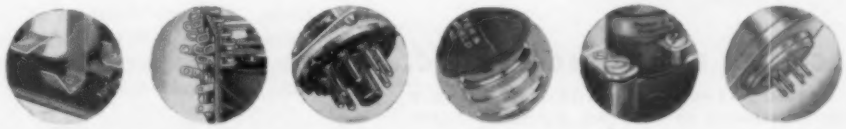
Whether your design calls for a large open relay or a miniature sealed one, P&B can supply it with any type of mounting or termination you desire.

P&B's engineering foresight has anticipated your assembly problems; designing, versatility and flexibility into each of their relay types.

Let our engineering group with a quarter century of relay "know how" become part of your design team. Send your specifications for recommendations and quotations.

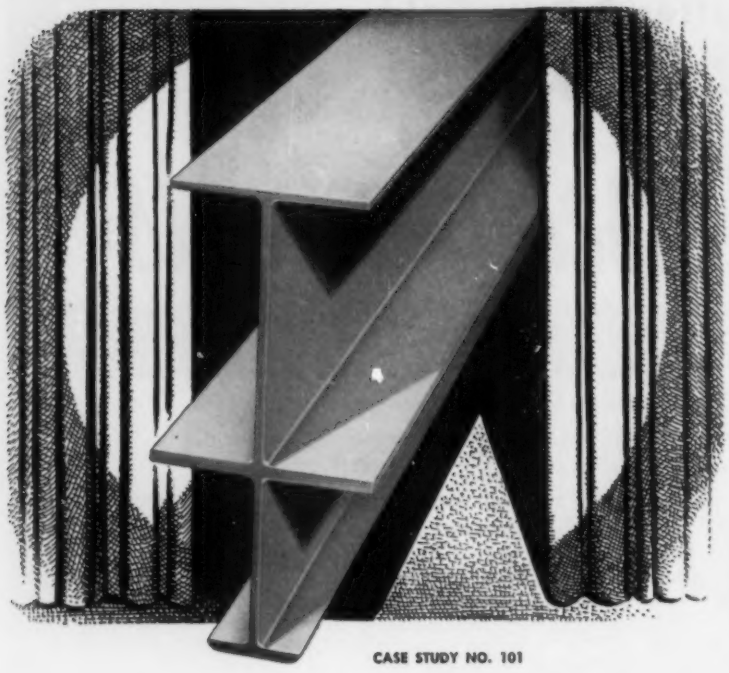
For quick delivery over 350 different standard relays stocked by 500 Franchised Electronic Parts Distributors throughout the United States and Canada.

Potter & Brumfield
PRINCETON, INDIANA
SUBSIDIARY OF AMERICAN MACHINE AND FOUNDRY



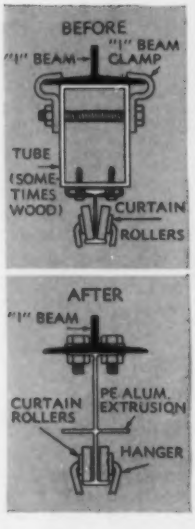
Clip-on solderless | Pierced solder lug | Tube type octal plug | AN type connector | Standard screw terminals | Up to 14 pin plug-in

Art Drapery Studios rate repeated curtain calls



CASE STUDY NO. 101

HOW *PE* ***EXTRUSIONEERING**** **CUT TRACK COSTS 50%**



Art Drapery Studios, 2739 N. Racine Ave., Chicagoland designers and installers of stage curtains and gymnasium dividers, had a track problem—and tracks are an important part of any job they do. Over-all costs were high because of drilling, assembling, splicing, and installation operations.

THE PROBLEM AND SOLUTION

Could Precision Extrusions, Inc. design a one-piece extruded aluminum track that would solve these problems? As illustrated, PE engineered a track that eliminates drilling, assembling, and splicing operations; simplifies installation; makes it easy to curve the track right on the job. In addition, both material and labor costs are cut 50%.

*** WHAT IS EXTRUSIONEERING?**

"Extrusioneering" is a PE *plus* service designed to assist you in developing new ideas to solve specific problems, to cut manufacturing costs, and to improve product quality.

Most likely your need is far removed from curtain tracks; but why not call in a PE engineer and let him work with you towards a solution to *your* problem—whatever it is. There is no obligation.

PRECISION EXTRUSIONS, INC.

729 GREEN AVENUE BENSENVILLE, ILLINOIS

PHONE: BENSENVILLE 98 • CHICAGO TUxedo 9-1701

Chicagoland's Oldest Aluminum Extruder

smaller and smaller machines to do bigger and bigger jobs. On this premise it includes many worked-out problems based on actual modern installations.

Each topic is approached from the elementary viewpoint and then carried to a degree not normally found in texts on machine design. For example, Chapters 3 to 8 analyze the design of parts for strength and rigidity. The analysis, however, includes the effect of holes and notches on the stress distribution of members, with examples of reduction in stress concentration by proper redesign. Supporting the theory are tables and graphs such as the influence of notch radius on notch sensitivity.

In addition to standard topics such as springs, fasteners, power transmissions, lubrication, surface finish and wear, are discussions on motor selection and vibration control. The chapter on motors includes charts for selecting motors based on application requirements. Numerous references are indicated throughout the text as footnotes to indicate the scope and sources of further developments.

American Standard Code For Pressure Piping

8½ x 11 *in.*, 137 *pp, paper-bound. Published by the ASME,* 29 W. 39 St., *New York* 18, N. Y. $3.50.

Sectional committee B31 has recently revised and published the Code (ASA B311-1955), which represents a minimum safety standard for materials, dimensions, design of components, as well as assembled units, including necessary supports, installation and test. While in most cases the requirements are mandatory, design recommendations have been included where they will be of assistance in securing safe piping systems.

Industrial Furnaces, Vol. II

W. Trinks, *Prof. Emeritus Mech. Engrg,. Carnegie Institute of Technology.* 6x9 *in.*, 358 *pp. Published by John Wiley & Sons, Inc.,* 440 *Fourth Ave., New York* 16, N. Y. $10.

This first revision in nearly fifteen years includes information on fuels and electric energy, their conversion

(Continued on page 367)

into heat, limits of temperature control, mounting of electric heating elements, application of protective atmospheres, material handling equipment, new burners, and furnace types. A comparison of fuels and furnace types based on economical first cost and running cost is made. A short chapter on safety has been added in this new edition.

Automatic Control Bibliography

WARREN F. WADE, *Massachusetts Institute of Technology* and EMORY N. KEMLER, *Professor of Mechanical Engineering, University of Minnesota.* 6½ x 8½ *in.*, 331 *pp. Published by Summary Reports, P. O. Box 176, Spring Park, Minn.* $15.

This book has done a commendable job of summarizing the important American and English works on control written since 1900. Short abstracts appended to the listings do not evaluate the articles, but convey the content where the article title fails to do so.

This bibliography of 1,623 articles is arranged alphabetically by authors and by magazines for those articles where no author was shown on the original. The bibliography is not completely classified because of overlapping subject matter in the various fields of application.

Engineering Metallurgy

L. F. MONDOLFO, *Prof. of Metallurgical Engineering, Illinois Institute of Technology,* and OTTO ZMESKAL, *Research Prof., College of Engineering, Dept, of Mechanical Engineering, Univ. of Florida,* 9¼ x 6 *in.*, 397 *pp. Published by McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y.* $7.50.

Although written as a college text for the teaching of metallurgy to engineering students primarily concerned with other fields, this book should also prove useful as a book to be read now and used as a reference later by practicing design engineers. This is because of the work's principal emphasis. Rather than simply describing metal products and their production and working, the authors have attempted

(Continued on page 370)

Fast change-overs are easy on the new

NP Power Drive Cylinder

This cylinder has *all* the *most wanted* design features . . . provides exceptional adaptability, quick assembly and disassembly. You can make *many* fast change-overs using the simplest tools. Cushioning is easily adjusted; packing and internal parts can be changed; operation modifications can be made quickly on the *basic* cylinder.

No other cylinder offers so many vital features: compact, streamlined design; lightweight aluminum alloy and steel construction with *no* sacrifice of strength; sealed-in lubrication which eliminates need for external line lubricators. Operates with air, water or oil without interchanging or adding parts.

RATINGS: air — 200 psi; water or oil — 500 psi; Bore diameters: 1½", 2¼", 3", 4". Mountings: foot, flange, pivot, clevis, trunnion

NATIONAL PNEUMATIC CO., INC. AND **HOLTZER-CABOT** DIVISIONS

125 Amory St., Boston 19, Mass.
Sales Service Representatives in Principal Cities throughout the World

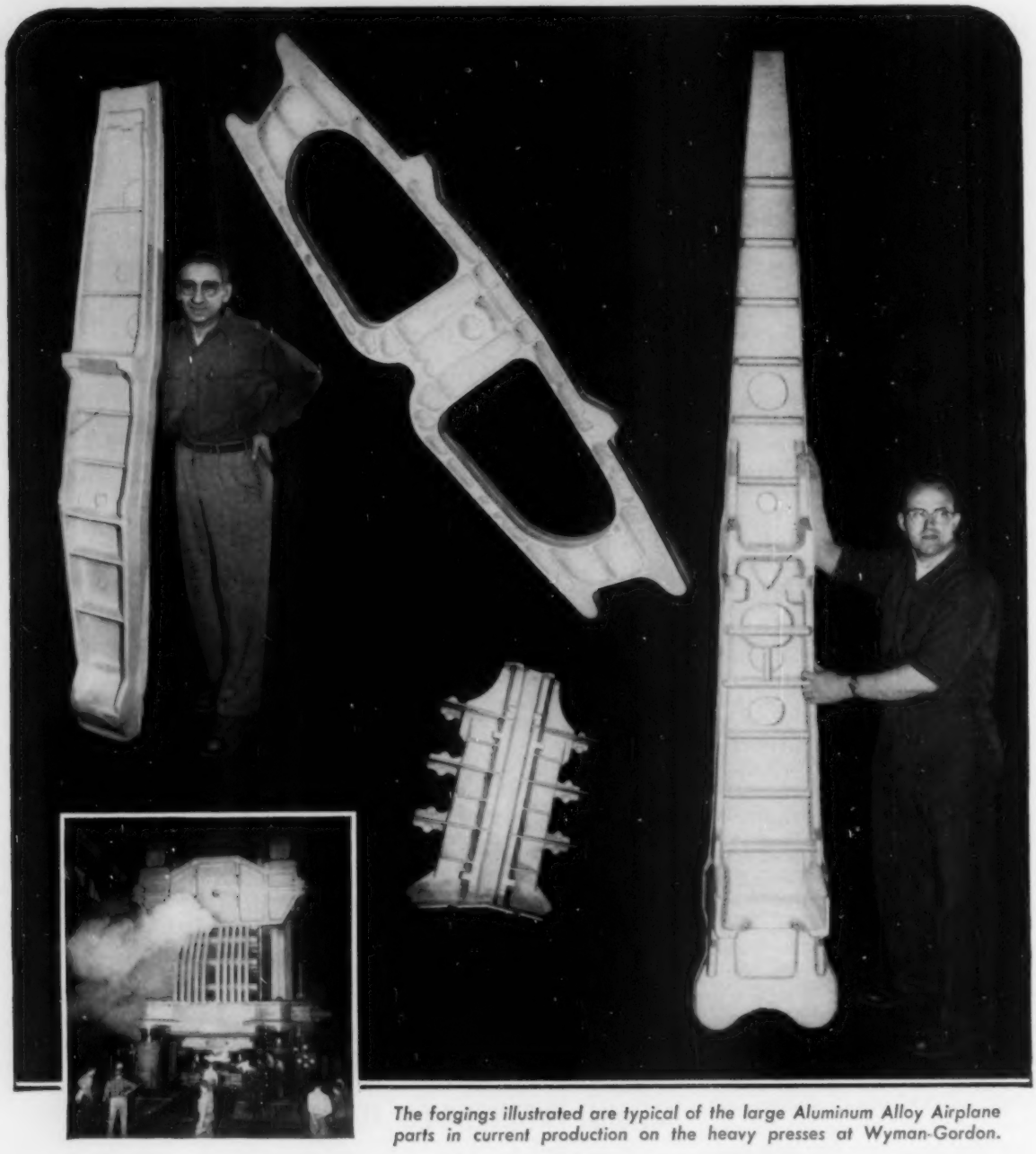
Designers and manufacturers of mechanical, pneumatic, hydraulic, electric and electronic equipment and systems

. . . Mail this coupon today for data sheets illustrating many other features . . .

INDUSTRIAL ACTUATORS AND CONTROLS DIVISION
NATIONAL PNEUMATIC CO., INC.
125 Amory Street, Boston 19, Massachusetts

Gentlemen: Please send me design information on the NP Power Drive Cylinder . . . Include information on NP Power Check feed control — NP Power Trol valves —

Name.....
Title.....
Company.....
Street.....
City..... *Zone* . . . *State*.....



The forgings illustrated are typical of the large Aluminum Alloy Airplane parts in current production on the heavy presses at Wyman-Gordon.

A new era in the art of forging has been demonstrated as production goes forward on this 35,000-ton closed die forging press. Larger forgings with thinner sections and closer tolerances than heretofore possible open new concepts in forging design. Wyman-Gordon continues to pioneer by — Keeping Ahead of Progress.

WYMAN-GORDON CO.

Established 1883

FORGINGS OF ALUMINUM • MAGNESIUM
STEEL • TITANIUM

WORCESTER 1, MASSACHUSETTS
HARVEY, ILL. • DETROIT, MICH.

Four Sizes
10-16-26-35
lb-in torque/100/psi

A New Series of DUAL-VANE Fluid Motors To Better Perform Functions Calling for Rotary Power

to better perform functions calling for rotary power. DUDCO Fluid Motors operate at higher continuous pressures . . . provide greater continuous horsepower output without increasing motor size. DUDCO Fluid Motors start, stop and reverse instantly, operate at an infinite variety of speeds, can even be stalled without damage.

DUDCO MF-100 Series Motors are built for continuous 2000 psi operation. They feature extremely high starting torques and provide constant torque throughout their entire speed range . . . start to 2400 rpm. Four sizes deliver up to 23.5 horsepower.

Member NFPA

Write for Bulletin No. DM-321

THE NEW YORK AIR BRAKE COMPANY

1112-1 EAST 222nd STREET • CLEVELAND 17 • OHIO

INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.

MOBILE EQUIPMENT BUILDERS TAKE TO HYDROSTATIC DRIVES

MODERN HYDRAULIC PUMPS AND MOTORS MAKE MACHINES MORE PRODUCTIVE

Nearly all types of mobile equipment require power at locations remote from the central power source. The transmission of this power has long been a problem to mobile equipment builders and operators. Complicated mechanical-type transmissions have proven costly and troublesome. Breakdowns were expensive in repair costs and lost production time.

Recently builders of mobile equipment have found a simple and dependable solution to this problem. They have been able to add functions to equipment and transmit power by the use of hydrostatic drives.

A hydrostatic drive generally consists of a constant displacement hydraulic pump, a constant displacement fluid motor, a directional control valve and connecting pipes or hoses. The hydrostatic drive effects power transfer by means of pressure changes rather than by velocity changes as do torque converters or fluid couplings.

Many advantages are found in the use of hydrostatic drives. Power is easily transmitted to remote and inaccessible places. Infinite speed ratios and accurate output speeds are possible. The operator can control his machine through run, idle or reverse operation with just a simple control valve. The system provides automatic overload and shock protection.

Successful applications of hydrostatic drives have been made on farm machinery to operate cutter bars, drive combines and run conveyors. On construction equipment they drive ditchers, rotate grader blades and operate cranes and winches. In the materials handling field these drives rotate clamps and propel small platform trucks. The adaption of hydrostatic drives to all types of machines seems unlimited.

DUDCO MF-100 Series Fluid Motors and PFM-100 Series Hydraulic Pumps have been developed by The New York Air Brake Company to provide hydrostatic drives for equipment which must give continuous, dependable service.

ENGINEERS

Exceptional opportunities for men of imagination to express new ideas in the design and development of Hydraulic Components. Company expansion and progress in this growing industry promise rewarding futures for engineers who qualify. Write, giving experience and full details.

The New York Air Brake Company
1112-1 East 222nd Street
Cleveland 17, Ohio

Gentlemen:

I would like further details on the new DUDCO MF-100 Series Fluid Motors ☐
Also details on DUDCO PFM-100 Pumps ☐

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

AFFILIATE OF GENERAL CERAMICS CORPORATION

Magnetic Amplifiers · INC

—announces its new

VARIABLE SPEED DRIVE

MAGNE-SPEED*

SIZE II — 3/4, 1 and 1-1/2 HP

SIZE I — 1/4, 1/3 and 1/2 HP

Stepless, instant starting, compact, 50:1 speed range, good regulation without tachometer, long life, virtually maintenance free service, low cost, fast response, reversibility, dynamic brake, local or remote control. Write for Bulletin S580-5-55.

Other MA Products and Services

Magnetic Servo Amplifiers
Transi-Mag * Amplifiers
Analog Computors
Photoelectric Controls
DC and AC Regulated Power Supplies

* Trade Name

Application engineering and conversion of tool machines and production processes to automatic control.

Magnetic Amplifiers • Inc
Tel. CYpress 2-6610 • 632 TINTON AVE., NEW YORK 55, N. Y.

to describe the basic concepts and theories on which the various processes of extracting, refining, forming, treating and joining metals and alloys are based. How these theories affect the materials the engineer must use is emphasized.

The first part of this volume is devoted to a description of the extraction of metals from their ores and the preparation of commercially pure metallic products ready for the rolling mill or foundry. An analysis of metal structure and phases and their effects on various alloys and their properties follows.

Separate chapters are provided on casting principles, casting practice, plastic deformation and annealing, heat treatment, joining, powder metallurgy, corrosion. The last two chapters discuss, separately, ferrous and nonferrous metals.

Principles of Metal Casting

RICHARD W. HEINE, *Assoc. Prof. of Mining and Metallurgy, University of Wisconsin,* PHILIP C. ROSENTHAL, *Professor of Mining and Metallurgy, University of Wisconsin.* 6½ x 9¼ in., 639 pp. *Published by the McGraw-Hill Book Co., Inc.,* 330 W. 42 *St., New York* 36, *N. Y.* $7.50.

This book covers molding processes including the sand casting methods, shell molding, die and permanent mold casting, investment, mold materials and construction, molding equipment, solidification of metals, gating and feeding of castings, molding sand technology, cleaning of castings, castings design, metallurgical principles associated with melting, composition of casting alloys and their properties, heat treatment, and metallurgical processing characteristics of foundry practices. No processes other than metal casting are considered. Sample questions and calculations, tables, graphs, line diagrams, photographs are used to illustrate the principles.

Principles associated with molding processes and materials, solidification of metals and castings are presented in the first eleven chapters; the principles are then interpreted for the specific casting alloys (fourteen chapters); the special metallurgical princi-

(Continued on page 371)

ples of melting, alloying, heat treating, and metallurgical processing are confined to portions of the latter fourteen chapters. This arrangement also makes it possible to omit metallurgical materials if desired, since the book is intended for both metallurgical and mechanical engineering students, and can be readily adapted for either short or longer courses.

The most recent advances in the science of metal founding are included: methods of calculating the size of risers for feeding castings, and determination of their location; principles of fluid flow applied to the gating of castings; calculation and design of gating systems for controlling pouring time; calculation and graphical determination of mechanical properties of cast irons; technology and molding sands.

ASTM Viscosity Index

6½ x 9½ in., 826 pp. Published by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. $8; Members—$6.

These tables permit direct reading of the viscosity index of a petroleum product or lubricant if its kinematic viscosities at 100 and 210 F are known. This eliminates lengthy calculations.

The viscosity index is an empirical number that indicates the effect of change of temperature on the viscosity of an oil. A low viscosity index signifies relatively large change of viscosity with temperature.

The New American Machinist's Handbook

Edited by RUPERT LE GRAND, *Senior Assoc. Editor, American Machinist. 5⅝ x 8¼ in., 1579 pp. Published by McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y. $11.*

As a reference handbook, as a volume for self-study, as a practical summary of man's up-to-date methods of working metal, this complete revision of Colvin's and Stanley's original handbook should prove valuable to all those active in the manufacturing process. This specifically includes those involved in those phases of product design where the characteristics and

(Continued on page 375)

Meeting Today's Needs with Research . . .

Chief Sandusky

FERROUS AND NON-FERROUS CENTRIFUGALLY CAST ROLLS, SLEEVES, TUBES, LINERS, CHUTES, RETORTS, RINGS, BUSHINGS, BEARINGS, ETC.

Here you'll find a skilled staff in completely equipped laboratories testing new materials, developing new processes, helping to make better castings for your specific requirements.

These improvements are directly translated into uniform, strong, close-grained ferrous and non-ferrous castings with extreme resistance to corrosion, heat, and abrasion. As another service, the Chief offers machining facilities for turning, boring, and drilling.

Bring your casting problems to the Chief's thoroughly trained specialists. These men are always available to apply their broad experience to your particular needs.

C. M. Lovsted & Co., Seattle, Wash. • Tynes Bros., Birmingham, Ala. • Cordes Bros., San Francisco and Wilmington, Calif.

Chief SANDUSKY CENTRIFUGAL CASTINGS

FERROUS AND NON-FERROUS

SANDUSKY FOUNDRY AND MACHINE CO., Sandusky, Ohio

Now... new flexibility... economy in machinery design made possible by

PREMIUM V BELTS *reinforced with* DACRON

REG U S PAT OFF
POLYESTER FIBER

Greater power-handling capacity... lower drive costs... easier matching with this stronger, more stable reinforcement!

To meet today's demand for smaller, more compact, more economical v-belt drives, manufacturers have developed premium v-belts reinforced with "Dacron"* polyester fiber that:

1. Lower drive cost.
2. Save valuable space.
3. Transmit up to 40% more horsepower, depending on belt construction.
4. Withstand greater shock loading.
5. Have longer flex life.
6. Are more stable.
7. Have less stretch.
8. Require less maintenance.

"Dacron" in v-belts is approximately 40% stronger than conventional fibers. It is highly resilient—"gives" under high impact—but resists stretch and compression. And the low moisture regain of "Dacron"—only 0.4%—assures dimensional stability to changes in humidity.

Because these new high-strength, low-stretch v-belts permit use of fewer belts and smaller sheaves, they are more economical to install and to maintain.

For your next drive, consider the advantages of premium v-belts made with "Dacron". They combine the unique properties of "Dacron" polyester fiber made by Du Pont and the highest skills of leading manufacturers who make the belts. E. I. du Pont de Nemours & Co. (Inc.), Textile Fibers Dept., Wilmington 98, Delaware.

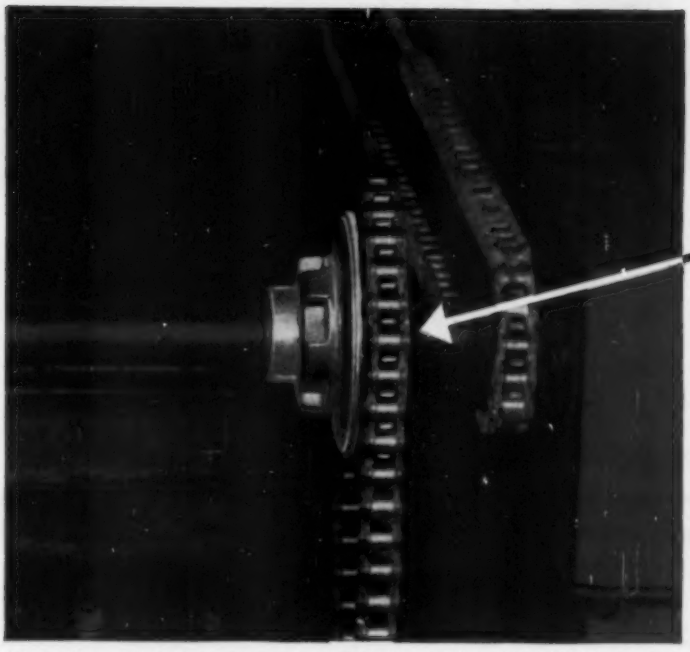
*"Dacron" is Du Pont's registered trademark for its polyester fiber.

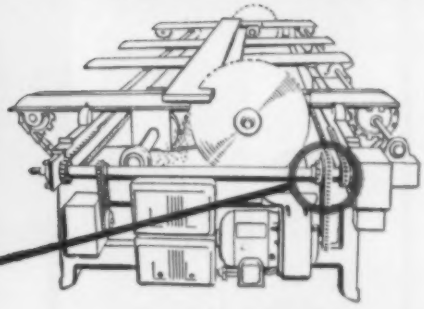
COST COMPARISON

		Width of Sheave (Inches)	Cost (Dollars)
STANDARD BELTS (Total Rated Capacity 45.5 HP)			
Motor Sheave	10" p.d., 5C groove	5.375	38.68
Mill Sheave	20" p.d., 5C groove	5.375	64.08
V-Belts	5 standard C 144 "Matched Belts"		48.00
			150.76
PREMIUM BELTS Reinforced with "Dacron" (Total Rated Capacity 50.4 HP)			
Motor Sheave	10" p.d., 4C groove	4.375	32.62
Mill Sheave	20" p.d., 4C groove	4.375	54.03
V-Belts	4 premium C 144 "Matched Belts"		52.72
			139.37

DU PONT
REG. U.S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING ... THROUGH CHEMISTRY

MORSE TORQUE LIMITER PROTECTS MOTOR AND REDUCER FROM DEAD-STOP OF DRIVEN UNIT!





Morse Torque Limiter and sprocket act as slip clutch on Model 55 Automatic Electric Shift Trimmer made by The Wheland Company, Chattanooga. Arbors are shifted at 120 fpm, instantly stopped and locked into place. Torque Limiter on jackshaft is set so sprocket slips when motor torque (38 ft.-lbs.) is exceeded. Absorbs inertia of 1-hp, 155-rpm gearmotor; reduces shock on drive unit when driven shaft is stopped.

Typical application shows how you can safeguard drive units and eliminate shear pins

Check these advantages of Morse Torque Limiters

- √ Eliminate downtime
- √ Torque-sensitive and fully adjustable
- √ Completely automatic and dependable
- √ Resume operation automatically
- √ Compact, standard sizes

In this Wheland Electric Shift Trimmer, two 200-pound saw arbors are automatically moved into position at 120 feet per minute . . . then stopped dead and locked into place.

The tremendous shock transmitted to the drive mechanism when the arbors are stopped, is safely dissipated by a Morse Torque Limiter used as a slip clutch between the driving and driven units. In addition, it prevents motor inertia from building up torque in the drive.

Versatile Morse Torque Limiters can safely control many of the shock-load problems present in your machine operations.

These simple devices are dependably sensitive and easily adjusted to desired torque limits. When overload or jam-up is cleared, they automatically resume operation, eliminating downtime or dismantling necessary with shear pins.

Send for Free Catalog

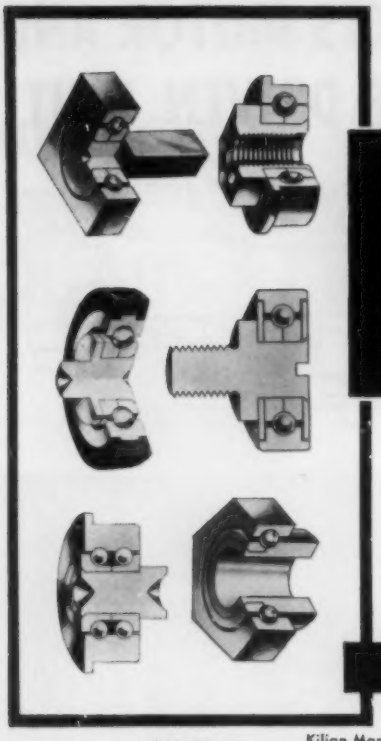
A full line of Torque Limiters is stocked by your Morse Distributor. For free catalog, or power transmission engineering help, see him or write today.

MORSE CHAIN COMPANY • INDUSTRIAL SALES DIVISION • ITHACA, N.Y.

MORSE

BW

CHAINS, CLUTCHES, AND COUPLINGS



UNGROUND BALL BEARINGS

For All Industries

KILIAN

Long life and service are assured you because —

1. All component parts are machined from steel bars.
2. Each component part is properly heat treated.
3. Every Kilian Bearing is designed for a specific application.

Neoprene and Nylon tired outer races are available where quiet operation is desired.

Distributors in All Principal Cities ***Catalog on Request***

KILIAN MANUFACTURING CORP.

SYRACUSE, NEW YORK, U. S. A.

ASSOCIATED COMPANIES: Kilian Manufacturing Corp. (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont. — Fischer Bearings (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont. — Kilian Steel Ball Corporation 100 Wellington St., Hartford, Conn.

use these
GRIPCO CLINCH NUTS
with the exclusive
hex on hex
feature

for "fixed" fastenings for "hard-to-reach" or blind assemblies. They wear longer, hold tighter, give greater customer satisfaction.

See how leading appliance manufacturers get lower cost fasteners into inaccessible places.

Gripco Clinch Nuts can be either clinched solid for a rigid application or staked in with a six point staking punch to give a floating effect. This floating effect takes care of misalignment and makes the application of the bolt easier. Gripco clinch nuts can be clinched or staked with stationary or portable hydraulic or air equipment. Details on request. Write for samples and data sheet.

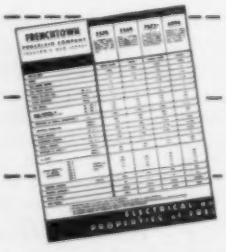
GRIP NUT COMPANY 113

308-J S. Michigan Avenue, Chicago 4, Illinois

engineered ceramics?

IF YOU ARE LOOKING for a supply source capable of providing high-performance materials that give you resistance to high temperatures and low thermal expansion; excellent mechanical strength and wear resistance; superior dielectric strength and both high and low frequencies—

A GOOD SOLUTION to your problem is to check with Frenchtown. As one of America's leaders in engineered ceramics for over 40 years, we are in a position to serve you in three ways: (1) providing research facilities for product improvement through *engineered* ceramics, (2) assisting in design and development work, (3) producing required parts and components in any quantity, to your most exacting specifications. Want to know more? Write for literature.



frenchtown PORCELAIN COMPANY

87 Muirhead Avenue • Trenton 9, New Jersey

effects of production techniques constitute factors to be taken into consideration.

Although condensed, this book is a rather complete source of detailed information on metals and all the currently significant methods of machining, forming, joining and finishing them. The essentials of important engineering literature, engineering and product standards and full descriptions of the best shop practice are included. Other chapters are devoted to inspection techniques, fastening devices, tool engineering and drafting practice, machine tool standards, power transmission equipment, mathematics and tables.

Reorganized and with a new format, the new handbook is said to be more than 80 per cent rewritten.

Developing Your Executive Skills

AUREN URIS, *Editor, Human Relations Div., Research Institute of America.* 5½ x 8½ *in., 270 pp. Published by McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y.* $4.50.

There are chapters in this book on some of the various aspects of the executive's role today, including how to be a good administrator, decision-making, long-range planning, executive problem solving, communication, working with subordinates, correspondence, interviewing, sharpening mental focus and memory. The book also contains self-analysis tests and quizzes, charts such as a guide for long-range planning, a communications analyzer, and a personal efficiency guide. The many case histories will prove an enlightening study for the young executive on the way up.

Machining Aluminum

Kaiser Aluminum & Chemical Sales, Inc. 5½ x 8½ *in., 308 pp. Published by Technical Publications Dept., Kaiser Aluminum & Chemical Sales, Inc., 228 N. LaSalle St., Chicago 1, Ill.* $2.

Another excellent reference book in Kaiser's series on aluminum fabrication with much practical information on machining the various alloys of this

(Continued on page 379)

Precision gears custom-made by Perkins
meet your specs
and *your time-table*

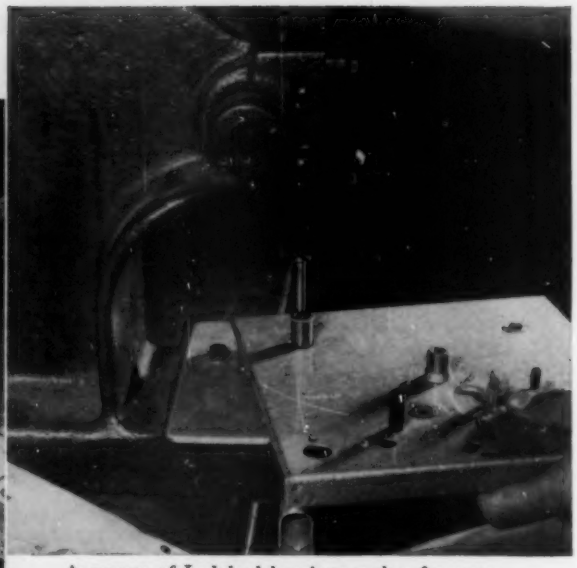
Throughout industry, the name PERKINS in association with GEARS has long been symbolical with quality and service. Hence — be they washing machines or supersonic aircraft engines — if the component gears of the finished product are *custom-made by Perkins*, they will be *better* products. *You furnish the specifications, we'll produce the gears!*

PERKINS MAKES in all materials, metallic or non-metallic, and in any size, to your specifications: helical gears, bevel gears, sprockets, ratchets, worm gears, spur gears with shaved or ground teeth, ground thread worms.

NOTE: The **PERKINS PRECISION SPRING COILER** is the latest development in the spring coiler field and eliminates entirely the use of arbors and long set-up time. It is a complete self-sufficient machine and enables you to make the spring you want *when* you want it — in seconds. The coiler produces any type of spring, in any diameter and any pitch with this range: Wire Sizes .005 to .125. Diameter from 3/32" to 12" and larger. Size of the compact coiler is only 7½ x 16". **A POWER MODEL** mounted on a welded steel console cabinet base is also available. Full information on request.

Perkins Machine & Gear Co.
105 Circuit Ave., West Springfield, Mass.

Johnson Ledaloyl self-lubricating bearings hold oil like a sponge—will never need oiling for the life of Telectro tape recorders. Here one is being slipped on to the shaft of component.



Accuracy of Ledaloyl bearings makes for snug press-fit in the base plate of Telectro recorder.

A handful of trouble-free service for Telectro—Johnson Ledaloyl bearings assure durability of recorder, yet are economical and easy to install.

For Accuracy, Durability And Economy, Telectro Industries Uses Johnson Ledaloyl Self-Lubricating Bearings

Telectro Industries Corporation of Long Island City, New York, insists that every component of their wire and tape recorders must have the quality and stamina to give trouble-free service for the life of the machine.

That is why they chose Johnson Ledaloyl bearings according to Mr. Roy Yasen, Purchasing Agent, who says: "Everything considered—accuracy, price and delivery—we find these self-lubricating bearings to be the most durable in this price range." "People who buy these recorders won't be bothered with taking them apart to oil bearings," continues Mr. Yasen, "that's why we use Johnson Ledaloyl bearings, that have the oil right in them. They last as long as the machines, without lubrication."

A Johnson distributor services Telectro, gives them immediate delivery on stock sizes, calls in a Johnson field engineer to help work out any special items.

Your local Johnson distributor has available more than 400 stock sizes in three basic types—he will be glad to work with you in developing new economy and performance in the items you manufacture. Johnson Bronze Company, 508 South Mill Street, New Castle, Pennsylvania.

Johnson Bearings

GRAPHITED
over 175 sizes

GENERAL PURPOSE
over 900 sizes

UNIVERSAL BRONZE BARS
over 400 sizes

LEDALOYL
over 400 sizes

ELECTRIC MOTOR
over 350 sizes

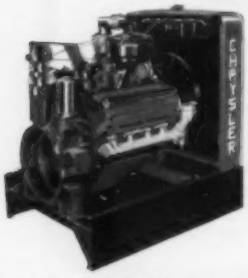
Install Chrysler Industrial Engines

...best-engineered, most-economical answer to your power problem

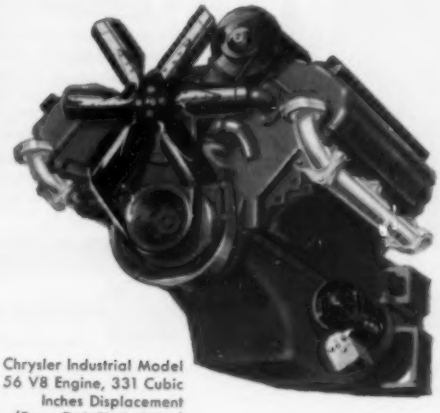
Chrysler Power is the *dependable*, economical, lightweight answer to your high-speed or high-torque power requirements. Within their power ranges, each Chrysler Industrial Engine is a leader in the field and is recognized as such by manufacturers of almost every type of self-powered equipment.

Check the specifications. Note the optional equipment which can be factory supplied or installed to meet the particular requirements of your equipment in the field. Whether equipped for Gasoline, Distillate Fuel, Propane or Natural Gas operation, Chrysler Industrial Engines offer definite advantages . . . performance, ease of maintenance, fast parts service, low initial and operating costs.

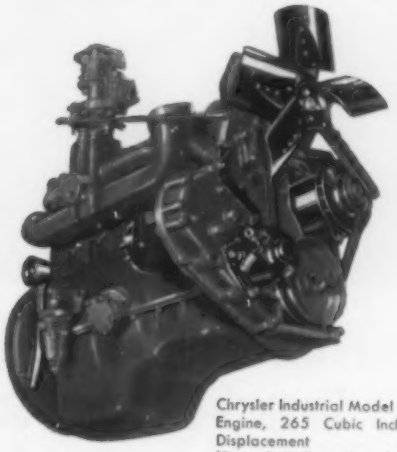
See the dealer nearest you, or write for complete information. ***Dept. 31, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.***



Chrysler Open Power Units. The open power units for all engines include the complete engine, skid base, radiator, instruments and instrument panel, flywheel and flywheel housing. Open power units for V-8 Models Ind. 52 and 56 (pictured), include twenty-five gallon fuel tank.



Chrysler Industrial Model 56 V8 Engine, 331 Cubic Inches Displacement (Front End Chain Drive)



Chrysler Industrial Model 33 Engine, 265 Cubic Inches Displacement (Front End Gear Drive)

Chrysler Enclosed Power Units. The enclosed power units have the complete engine, fuel tank (Models Ind. 30, 31, 32 and 33—sixteen gallon. Models Ind. 52 and 56—twenty-five gallon), storage battery, instruments and instrument panel, flywheel, flywheel housing, skid base and completely enclosing sheet metal.

Optional Equipment—Chrysler Engines

- Chrysler Industrial Torque Converter
- Chrysler gyrol Fluid Coupling
- Three, Four or Five-Speed Transmission
- Twelve or Twenty-four Volt Electrical System
- Distillate, Propane or Natural Gas Burning Carburetor
- Over-Center Clutch and Power Take-Offs
- Vertical or Horizontal Magnetos
- Flexible Coupling for Truck-Type Flywheel
- Radio Shielding and Ignitors
- Heavy-Duty Oil Bath Air Cleaners
- Safety Switches (Low Oil Pressure, High Water Temperature)
- Corrosion or Fungus Resistant Electrical System

GENERAL SPECIFICATIONS ALL MODELS

	Ind. 30	Ind. 31	Ind. 32	Ind. 33	Ind. 52	Ind. 56
No. of Cylinders	6	6	6	6	8	8
Type of Engine—4 Cycle	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Gasoline
Bore—Inches	3 1/8	3 1/8	3 7/16	3 7/16	3 5/16	3 13/16
Stroke—Inches	4 5/8	4 5/8	4 3/4	4 3/4	3 1/4	3 5/8
Displacement—Cu. In.	230	230	265	265	270	331
Compression Ratio	7.0	7.0	6.8	6.8	7.5	7.5
Valves—Arrangement	L	L	L	L	Vee	Vee
Pistons—No. Rings	4	4	4	4	3	3
Crankshaft—Bearings	4	4	4	4	5	5
Camshaft Drive	Silent Chain	Gear	Silent Chain	Gear	Silent Chain	Silent Chain
Camshaft—Bearings	4	4	4	4	5	5
Crankshaft—Bearing Diameter	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 3/8"	2 1/2"
Lubrication—Type	Press.	Press.	Press.	Press.	Press.	Press.
Lubrication—Type Oil Pump	Rotor	Rotor	Rotor	Rotor	Rotor	Rotor
Lubrication—Oil Capacity Qts.	5	5	5	5	5	5
Ignition—Battery Type	Yes	Yes	Yes	Yes	Yes	Yes
Spark Plug—Size	14 mm	14 mm	14 mm	14 mm	14 mm	14 mm
Starting—Elec. Type	6 Volt	6 Volt	6 Volt	6 Volt	6 Volt	6 Volt
Gen. Reg.—Full Voltage	45 Amps.	45 Amps.	45 Amps.	45 Amps.	45 Amps.	45 Amps.
Gen. Reg.—Full Voltage and Current Control	Yes	Yes	Yes	Yes	Yes	Yes
Carburetor—Type	Down-Draft	Down-Draft	Down-Draft	Down-Draft	Down-Draft	Down-Draft
Fuel Pump	Yes	Yes	Yes	Yes	Yes	Yes
Weight—Approx. (Lbs.)	575	610	740	760	591	845

Specifications subject to change without notice.

HORSEPOWER WITH A PEDIGREE

CHRYSLER INDUSTRIAL ENGINES

INDUSTRIAL ENGINE DIVISION • CHRYSLER CORPORATION

WHAT'S NEW AT BRISTOL...

Automation and Bristol Through-Broached Screws cut assembly time at Burroughs

BURROUGHS, DETROIT, reports that Bristol patented Through-Broached Socket Screws, hopper-fed to a power screwdriver, cut in half the time required to insert set screws in critical stop dogs for their Sensimatic Accounting Machine.

THAT'S NOT ALL. Machine-fed Bristol screws not only eliminate a tedious hand operation, but also cut loss of screws due to dropping and cross threading.

HOPPER-FEED is no problem with the double-ended, symmetrical Bristol Through-Broached Socket Set screw. It has all the holding power of a standard socket set screw but, to facilitate machine assembly, the socket is broached all the way through so it can be inserted from either end.

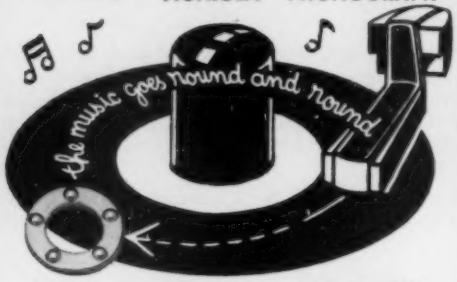
Write to The Bristol Company, Socket Screw Division. A5.5

LARGE AND SMALL—WE MAKE THEM ALL

Standard in sizes as small as No. 0 in Alloy Steel and Stainless Steel.

THE BRISTOL COMPANY, Socket Screw Division, Waterbury 20, Conn.

with every RCA VICTOR "VICTROLA" PHONOGRAPH



ON A HARTFORD THRUST RETAINER

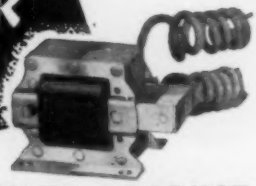
Fine enough for the brilliant $1600.00 Mark I new Orthophonic High-Fidelity "Victrola" Phonograph . . . yet inexpensive enough for the $12.95 economy model, Hartford Thrust Retainers will be found in RCA Victor record players. They insure a properly balanced turntable. Minimize rumble and background noise, give better tracking and lower running torque. Why not let Hartford solve your bearing problems?

Hartford

PRECISION BALLS • BEARINGS

The Hartford Steel Ball Co., Inc., 3 Jefferson Ave., W. Hartford 6, Conn.

DORMEYER SOLENOIDS are



ENGINEERED TO YOUR PRODUCT

Dormeyer Solenoids are built to your specifications in every detail. Constructed from only the finest materials, each unit is carefully inspected for uniform high quality.

No matter what your requirements are, we will supply them. Expanded facilities enable us to offer the widest variety of solenoid types in the industry.

DORMEYER TRANSFORMERS AND COILS

Built to the same high engineering standards as Dormeyer Solenoids. Compact, efficient—outlast equipment life. Coils to No. 50 wire.

PROMPT DELIVERY IN ANY QUANTITY

Send specifications for free estimate.
Request catalog giving full engineering data.

DORMEYER INDUSTRIES
FACTORIES IN CHICAGO AND KENTLAND, INDIANA
3414 MILWAUKEE AVENUE • CHICAGO 41, ILLINOIS

material. Profusely illustrated with clear sketches and photos and including many quick-reference tables, charts and nomographs that are useful to the designer as well as the machinist.

Information is divided into sections depending upon the operations performed: general machinability, milling, turning, drilling, reaming, tapping, boring, shaping, planing, broaching, grinding, filing, sawing, nibbling, and cutting fluids.

The book provides a guide in selecting a specific alloy for a given design and also aids in choosing the most suitable methods of machining for the metal-working equipment available. A glossary of terms common to machining is also included.

Free copies may be obtained when requested on company letterhead, by addressing Technical Editor, Kaiser Aluminum & Chemical Sales, Inc., 228 N. LaSalle St., Chicago 1, Ill.

High Temperature Corrosion Data

NACE Technical Committee Reports, Publication 55-6, booklet, 11¼ x 8 in., 6 pp. Published by the National Association of Corrosion Engineers, 1061 M & M Bldg., Houston 2, Texas. $0.50.

Information on the high temperature corrosion behavior of 31 materials ranging from cast iron to lead and including some non-metallics has been tabulated and published by the NACE. The report was compiled by Technical Unit Committee T-5B.

The data cover a number of stainless steels and high alloys subjected to temperatures over 400 F. Corrosion rates are given as low, moderate or high versus specific temperatures.

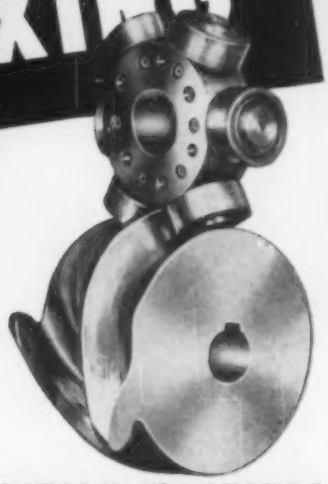
Bearing Lubrication Analysis

R. R. Slaymaker, *Professor of Machine Design, Case Institute of Technology, Consulting Engineer, Cleveland Graphite Bronze Co. 6 x 9¼ in., 108 pp. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. $5.*

Written for the machine designer rather than the lubrication specialist, this book covers the general princi-

(Continued on page 380)

HIGH SPEED INDEXING



WHEN TO SPECIFY A FERGUSON DRIVE

IN YOUR NEW PRODUCTION MACHINERY

WHEN INDEXING SPEEDS LIMIT YOUR PRODUCTION...

OR IF YOU REQUIRE SMOOTH STARTING AND STOPPING...

OR YOU NEED PRECISION OF .001" WITHOUT AUXILIARY LOCKING DEVICES...

OR IF MAINTENANCE "DOWN TIME" IS A MAJOR PROBLEM...

There's No Place in Automation for Obsolete Indexing Devices

Modern production methods require speeds and precision impossible to obtain with geneva drives and other obsolete indexing devices. The Ferguson Roller Gear Drive makes it possible to increase production speeds as much as 100%, *while improving product quality and reducing maintenance costs!* The Ferguson Drive, the greatest development in indexing in the last thirty years, attains indexing speeds up to 1,000 per minute in some applications without undue shock or vibration to the Drive or machine. If you have machinery utilizing dial feeds, roll feeds, carrier chains and other types of intermittent feeding methods, investigate the Ferguson Drive and discover what it can do for you.

NOW IN STOCK!

CUT WEEKS OFF DELIVERY TIME!

The more widely used Ferguson Drives may now be ordered from stock with weeks cut off delivery time and prices reduced as much as 25%. Send in the attached coupon or write for Bulletin 105a to get full information, including load ratings, dimensions and data on selecting a Drive. Find out how inexpensive it is to modernize your production machinery, increase production and lower operating costs.

FERGUSON MACHINE & TOOL CO., INC.
ROLLER GEAR DIVISION
P. O. BOX 5841 ST. LOUIS 21, MO.

FERGUSON MACHINE & TOOL CO., INC.
Roller Gear Division Dept. B-1
P. O. Box 5841 St. Louis 21, Mo.

Send free copy of bulletin 105a and data on stock and standard Ferguson Drives for high speed precision indexing of production machinery.

NAME_____ TITLE_____

COMPANY_____

STREET_____

CITY_____ STATE_____

PRD TRANSISTOR-
MAGNETIC SERVO AMPLIFIER

—weighs only 21 ounces
—measures 3⅞ x 2½ x 2⅔

The Type R40G7W6 is a small transistor-magnetic amplifier which is specifically designed to drive parallel connected Bu Ord MK7 and MK14 400 cps servo motors from potentiometer, synchro or resolver data. The unit has a built-in silicon transistor preamplifier and requires no stabilizer, demodulator or d.c. power supply. Truly remarkable performance is achieved with this unit as can be seen from the complete specifications.

Specifications

Maximum output: 7 watts, 57 v a.c., 400 cps
Voltage gain: with MK7 motor 2000 with MK14 motor 2400
Bandwidth: 0 - 70 cps
Zero drift: less than 3 mv ref. input
Saturation Signal: 50 mv
Input impedance: 15,000 ohms
Amb. temperature: −55° to +85°C
Stabilization: Internally provided
Power supply: 115 v ±10%, 400 cps
Hermetically sealed.
Meets MIL-E-5272, Procedure 1, Vibration Specifications.

Write for complete folder on PRD Magnetic Amplifiers

Polytechnic
RESEARCH & DEVELOPMENT CO., INC.
202 TILLARY STREET
BROOKLYN 1, NEW YORK
Telephone: ULster 2-6800

ples of lubrication analysis in bearing design. The author stresses sleeve bearings, the most common type of bearing found in machines. Its discussion is illustrated with case studies and numerical examples. There is an outline of hydro-dynamic theory as a guide to the design of bearings lubricated from an external source, a discussion of the characteristics of various bearing materials, and an analysis of the so-called oil-less bearings, intended to perform without an external supply of lubricant.

The topic of oil viscosity is emphasized. The author presents a method of predicting temperature rise and oil viscosity in one operation.

Brazing Manual

Prepared by Committee on Brazing and soldering, American Welding Society. 6 x 9 in., 193 pp. Published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. $4.75.

A much-needed book on one phase of welding that is increasing in importance. Prepared by a committee of experts in the field, an attempt was made to develop standards for the industry, including terminology. As a first effort, it is well done and should prove valuable to designers for reference as well as for basic information on the brazing process.

There are 11 pages on joint design, and the appendix contains a complete table of properties of brazable metals and alloys for handy reference.

The book discusses the 8 standard brazing processes, including all operations from precleaning and surface preparation to post-braze cleaning and inspection for aluminum, magnesium, copper, steels, iron, nickel and other metals and alloys.

Units of Weight and Measure

DR. L. V. JUDSON, *national Bureau of Standards, Miscellaneous Publication 214, 8 x 10½ in., 64 pp. Published by the NBS, U. S. Dept. of Commerce, Washington 25, D. C. $.40.*

This publication, superseding Miscellaneous Publication 121 issued in 1936, defines the units of length,

(Continued on page 383)

EACH PART OF A LOVEJOY UNIVERSAL JOINT IS PRECISION GROUND AND PERFECTLY FITTED

Lovejoy Universal Joints are precision-built for tough service . . . are light-weight, quick-acting to give sensitive response and smooth performance.

Compact construction makes them ideal for close quarter operation. Simplicity of design and absence of complicated parts assure dependability, long life and negligible maintenance.

Lovejoy's full line of standard sizes can provide you with the universal joint that is *just right* for any slow speed application. Special units can be made to individual specifications on request.

Standard sizes range from fractional to 207 hp., diameters ½" to 4", bores ¼" to 2", lengths 2" to 10⅝".

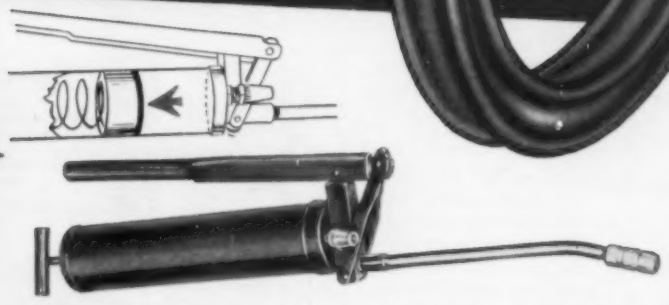
Contact Lovejoy now for complete information. Request bulletin.

LOVEJOY FLEXIBLE COUPLING CO.
4873 W. LAKE STREET • CHICAGO 44, ILLINOIS
Mfrs. of Flexible Couplings, Variable Speed Pulleys and Transmissions, Motor Bases and Universal Joints.

problem: *find a simple low-friction seal that's dependable over a wide ambient temperature range*

new answer: *minnesota rubber's money-saving new*

evidence:



STEWART-WARNER'S "ALEMITE FARM GUN #4026A" uses a QUAD RING (Q-30) as a follower ring to seal the grease in the cylinder. Basic requirements were low friction plus dependable sealing ability at a wide ambient temperature range. This new unit was greatly simplified because the QUAD RING eliminated several parts previously required in guns of this type. The contoured lips of the QUAD RING absorb the variations of standard tubing—still effecting a seal with considerably less squeeze than an O-ring. This low squeeze produced less friction—giving longer life.

QUAD RINGS are injection molded. Denser, tougher. 4-lip action even seals at 0 to 5 psi! Only 60-100 micro-inch groove finish needed. No parting line on sealing surface. Eliminates "spiral twist".

free samples and data: Free samples of QUAD RINGS are available with a descriptive brochure containing technical information and installation data.

minnesota rubber and gasket company

Originators of modern rubber injection molding

Dept. 201, 3630 Wooddale Ave., Minneapolis 16, Minn., Phone: West 9-6781

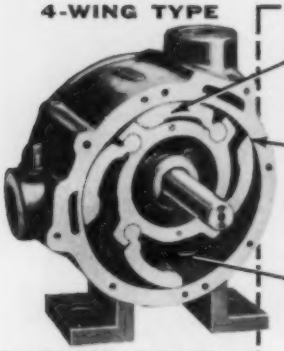
Exclusive Features of

LEIMAN Rotary Air and VACUUM PUMPS

bring you

★ High Vacuum
★ Greater Volume
★ Smaller Size
★ Lifetime Operation

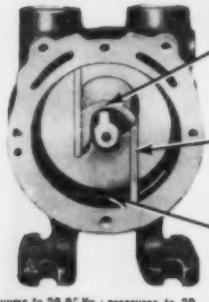
4-WING TYPE



- Curved Wings on easy-action hinge, maintain continuous wall contact.
- Cast Iron Wings and Cylinders hone themselves to hard, glassy smoothness—take up their own wear—assure leak-proof seal for years.
- Extra-large Air Space provides greater capacity, permits use of smaller pump.

Vacuums to 20" Hg.; pressures to 15 psig.; displacement to 162 c.f.m.

2-WING TYPE



- Automatic Wing Adjuster assures wing-to-wall contact, prevents sticking, guarantees positive action.
- Extra-long Steel Wings (not composition) provide long wear. Cylinder walls made of durable cast iron.
- Large air space provides more compact pump.

Vacuums to 29.9" Hg.; pressures to 20 psig.; displacement to 40.8 c.f.m.

Install LEIMAN AIR PUMPS

for dependable Vacuum (Suction) and Pressure

FREE ENGINEERING DATA

- *Application Book* showing 60 "how-to-do-it" blueprints of actual applications.
- 16-page *Catalog* showing construction, types, sizes, capacities, etc.

Precision-made, compact Leiman Air Pumps have fewer moving parts — no tips or blades to renew — need no maintenance except occasional oiling — run for 10, 15 and 20 years without trouble or shutdown. Over half a million installed. Consult our engineers on any air application.

SEE OUR CATALOG IN SWEETS FILE

LEIMAN BROS., Inc.

107 Christie St., Newark 5, New Jersey

Simplify assembly and setting of Adjusting Screws

The new Tension Type PALNUT Lock Nut is tightened *once* when assembled and never touched again no matter how often the screw is adjusted. Only a screwdriver is needed.

TENSION TYPE PALNUT LOCK NUTS
Trademark

How it works:

Resilient spring design assures smooth but powerful hold on screw threads for accurate settings, despite vibration.

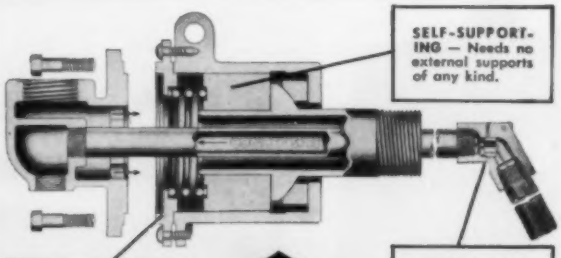
Barbs at the base prevent PALNUT from changing position when screw is adjusted. Back-off torque is twice installation torque.

Tension Type PALNUTS are lower in cost, require less space, are easier, more economical to assemble than other tension devices. They are adapted to manual or high-speed power assembly. Need no serrations, special holes or auxiliary holding means. Available for thread sizes 2-56, 4-36, 4-48, 6-32, 6-56 and 10-32.

Write for free samples and literature.

THE PALNUT CO., 65 Cordier St., Irvington, 11, N. J.

In Canada: P. L. Robertson Co., Ltd., Milton, Ont.



- **SELF-SUPPORTING** — Needs no external supports of any kind.
- **ASSEMBLY PLATE** — Holds internal parts in position when head is removed.
- **SYPHON ELBOW** — Permits use of straight pipe for syphon. Can be inserted or withdrawn right through the joint.

Johnson Rotary Joint with SYPHON ELBOW

Johnson Joints represent the best way industry has yet found to get steam or liquids into rotating rolls and cylinders. They are completely packless, need no lubrication or adjustment. The Type SBP shown gets steam in, condensate out, through the same head. Other types available for through flow service, in sizes to meet all operating needs. ***WRITE FOR COMPLETE INFORMATION.***

The Johnson Corporation

813 Wood St., Three Rivers, Mich.

mass, area, volume and capacity in use in the United States. It also gives tables of interrelation and tables of equivalents for these units in the metric system and in the U. S. customary system.

In addition, the volume contains sections of the fundamental equivalents, the approved spelling and abbreviation of each of the most common units of weight and measure, and the status of the metric system in the United States. All of the tables and other material have been revised to conform to current definitions, equivalents and usages. Conversion tables are confined to simple units, excluding all compound units such as foot-pounds, pounds per cubic foot, and feet per second.

Basic Mathematics for Science and Engineering

PAUL G. ANDRES, *Illinois Institute of Technology;* HUGH J. MISER, *Operations Analyst, USAF;* HAIM REINGOLD, *Illinois Institute of Technology,* 6 x 9¼ *in.,* 846 *pp. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.* $6.75.

This book is a revision of an earlier volume by the same authors published in 1944 under the title "Basic Mathematics for Engineers." The principal changes effected in the revision are these:

1. The text has been thoroughly reviewed and revised to insure that it meets the needs of scientific as well as engineering curricula. To this end, the applications treated, as well as many exercises and illustrative examples, have been drawn from varied fields of science as well as engineering.
2. The portion of the book devoted to analytic geometry has been expanded.
3. The exercises have been replaced.

Many lesser changes have been made in order to strengthen and improve the book. However, the organization and objectives of the book remain the same, and all of the principal features that distinguished the earlier volume from other texts in this field have been retained.

This book presents the mathematics required for elementary science and engineering courses and serves as a

(Continued on page 385)

Have You A Design Problem Involving Switches?

ACRO SNAP ACTION micro-switches Can Meet Most Requirements

OFTEN REDUCE COSTS, TOO

Whether you're designing a new product or redesigning an existing one, chances are that the Acro switches can ease your path. You see, no other line of snap-action switches comes in so many standard types. Hence, you can, in all probability, profit from the important savings of being able to use a production line Acro switch for your special needs. Too, there may be the opportunity to improve your products' performance . . . to solve production bottlenecks . . . to lower costs. Why not find out today? Write us and one of our sales engineers will call.

Write for CATALOG

This 36-page switch catalog belongs in every design engineer's file. It gives operating characteristics, dimensions and other specifications for nearly 100 types of Acro switches. Write for your copy today.

The Biggest Line of Little Switches

ACRO SWITCH DIVISION

ACRO MANUFACTURING COMPANY

COLUMBUS 16, OHIO

Plants at Columbus and Hillsboro, Ohio

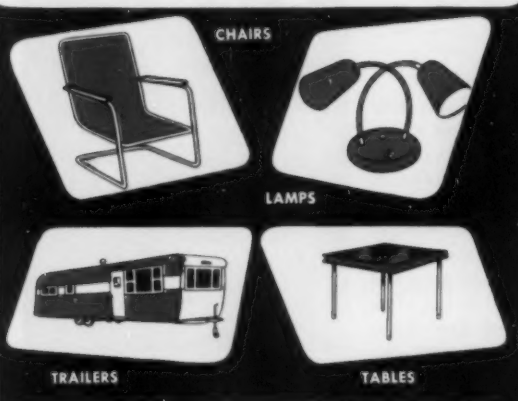
REPRESENTATIVES IN ALL PRINCIPAL CITIES

ELIMINATE EXPENSIVE FINISHING!

FABRICATE *Your* products from ALUMINUM PRE-ENAMELED COILS

Available in widths up to 36"

You can cut production time and increase output when you fabricate from pre-painted aluminum. Colorweld Coil, roller-enameled aluminum, retains its original color perfection throughout most fabrication stresses and production operations. Colorweld's baked-on enamel finish permits bending, forming, slitting, stamping and most drawing operations without scratching or peeling. By a special process, including careful Alodizing, the colors literally are welded to the metal for a lasting finish.



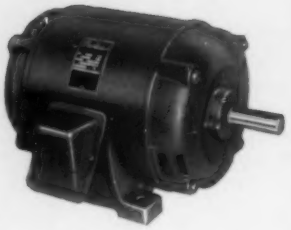
Colorweld Coil is available in widths ranging from ½" to 36", in thicknesses from .016" to .051". It can be coated in a variety of standard colors, enameled on one side or two, using the same or a different color.

To add sales appeal to your products at substantially reduced production costs, fabricate your products from Colorweld Coil. We shall be glad to send you additional information, without obligation. Write to us today.

Colorweld COIL

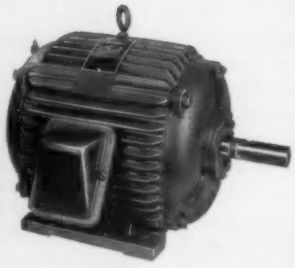
SOUTHERN STATES IRON ROOFING COMPANY
GENERAL SALES OFFICES, SAVANNAH, GEORGIA

NEW! NEMA RERATED FRAME DESIGNS



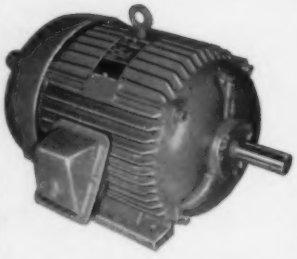
DRIP-PROOF (Open Type)

• Frame sizes from 56 thru 326. Cast-iron construction. Furnished with ball or sleeve bearings. All exterior surfaces are smooth and symmetrical. Streamlined design affords complete protection against dripping liquids or falling particles.



TOTALLY ENCLOSED NON-VENTILATED

• Totally enclosed, non-ventilated, from ½ to 3 HP. Recommended for use in non-explosive abrasive dust, metal dust, or where foreign matter may enter a motor. Positive protection of motor windings. Same design used with larger motors that drive propeller-type fans where the fan blows cooling air directly over the motor.



TOTALLY ENCLOSED FAN-COOLED

• Totally enclosed, fan-cooled, from ½ to 30 HP. Cooling air is drawn by an external fan across the motor towards the driven machine. Heat generated by the machine is not drawn across the motor. Same system used in standard, fan-cooled motors and explosion-proof designs.

Write for Bulletin SDA-155.

ELECTRIC MOTOR DIVISION
THE Peerless® Electric COMPANY
FANS · BLOWERS · MOTORS · ELECTRONIC EQUIPMENT
1509 W. MARKET ST. • WARREN, OHIO

preparation for a course in the calculus. It contains the topics from algebra, trigonometry, and analytic geometry that are needed to meet this dual objective. An attempt has been made to render the explanations and discussions unusually clear and complete so that the book can also be used for home study, or in courses where greater reliance than usual is placed on the student's reading.

Illustrative examples are worked out in full so that the reader can see in operation the principles discussed in the text and so that he has a clear procedure after which to pattern his own work.

One purpose of the book is to show the student how elementary mathematics is used in scientific and engineering applications. Therefore, the book contains many uses of scientific and engineering symbols and terminology, and numerous illustrations, graphs, examples, and exercises from science and engineering.

Introduction to Electronic Analogue Computers

C. A. A. Wass, Sr. *Principal Scientific Officer, Royal Aircraft Establishment, Farnborough, Hants, England and General Editor* D. W. Fry, *Atomic Energy Research Establishment, Harwell, England,* 5¾ x 8¾ *in.,* 231 *pp. Published by McGraw-Hill Book Co., Inc.,* 330 W. 42 St., *New York* 36, N. Y. $6.50.

This book is an up-to-date report on the present status of analog computing, constituting a professional description of analog differential analyzers and their components. Both theory and design are treated in a sufficiently basic manner to be applicable to U. S. developments and machines. There is an excellent set of references covering many items not common knowledge among American readers.

After introductory material, the author treats the mathematical problem statements of a variety of systems amenable to analog computer solution; these are discussed by means of simple, idealized computing networks which serve to introduce the basic characteristics of components. The

(Continued on page 387)

INVESTMENT CASTING IS ECONOMICAL IF...

- Performance requirements demand use of alloys that are difficult to form or machine.
- Intricate shape or unusual contours cause expensive machining, finishing, and/or assembly costs.
- Production runs too small to warrant machine set-ups.
- Part sizes are smaller than 10" or lighter than 10 pounds.
- Realistic tolerances and inspection standards are specified.

ARWOOD engineers will gladly help you with your design and production problems. They are casting specialists. Let them study your blueprints or a sample part and save you time, effort and money.

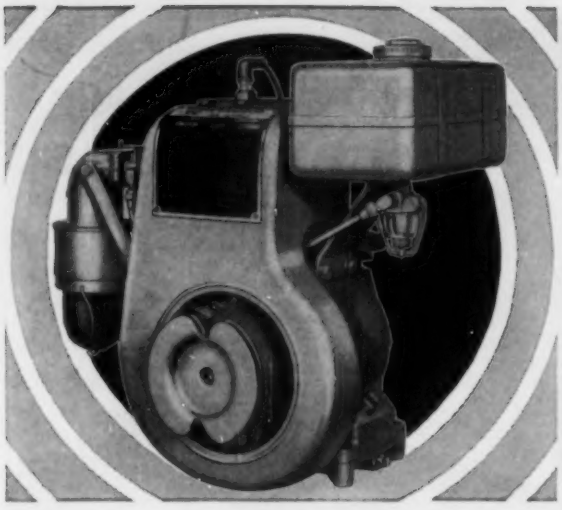
A CASE IN POINT!
LIGHTER, STRONGER, CHEAPER

Stainless steel hinge for military ordnance component was formerly composed of a stamped bracket and machined hinge, welded together and assembled to a complicated anti-rotation device. Entire unit is now cast in one piece and is lighter and stronger. Hole-reaming is only machining required.

Write TODAY for your FREE copy of "A Critical Survey of Investment Castings", written especially for design and production engineers.

ARWOOD

ARWOOD PRECISION CASTING CORPORATION
68 Washington Street • Brooklyn 1, New York
Plants: Brooklyn, N. Y. • Groton, Conn. • Tilton, N. H. • Los Angeles, Calif.
"PIONEERS IN INVESTMENT CASTING"



Another NEW

WISCONSIN Heavy-Duty *Air-Cooled* ENGINE

The Model BKN Single Cylinder 3.2 to 6.8 hp.

Brand new in design, this engine meets the increasing demand among original equipment manufacturers and engine power users for a compact, light weight, HEAVY-DUTY Air-Cooled Engine that offers a broad, flexible power range.

With a 17.8 cu. in. displacement, the new Model BKN delivers 6.8 hp. at its top speed of 3600 rpm., and 3.2 hp. at a minimum speed of 1600 rpm. Incorporated in this engine are all of the traditional Wisconsin Heavy-Duty features, including tapered roller bearings at *both* ends of the crankshaft; high tension rotary type *outside* magneto with Impulse Coupling; pump-circulated, constant-level splash lubrication system and efficient AIR-COOLING at all temperatures from sub-zero to 140° F.

The Wisconsin line of Heavy-Duty Air-Cooled Engines comprises a total of 12 different models, in 4-cycle single cylinder, 2- and 4-cylinder sizes, encompassing a power range of 2.3 to 36 hp. Here is power selectivity to fit your equipment requirements with maximum power advantage and economy — *Power to Fit the Machine and the Job.*

Our Engineering Department will be glad to co-operate with you in adapting Wisconsin power components to your equipment. For detailed data on the new Model BKN, write for Bulletin S-183.

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

$AVINGS in $TEEL

NOW POSSIBLE WITH THE NEW

Alumicoat

Molten Aluminum Coating Process

In many cases, expensive high alloy strategic steels may be replaced with low alloy steels which have received the ALUMICOAT Molten Aluminum Coating Process. Under high temperature conditions, these low alloy steels would ordinarily oxidize and scale, but after the application of the ALUMICOAT Process, they have proven superior to strategic alloy steels.

TABLE SHOWING ALUMICOAT PROTECTION

Steel Samples	Temp. F.	Time hrs.	Change in Weight*
WITHOUT ALUMICOAT			
18-8 Chromium Nickel	1,350	24	- 17.0%
25-20 Chromium Nickel	1,350	4	- 8.3%
27% Chromium Steel	1,350	24	- 8.4%
WITH ALUMICOAT			
Plain Steel	1,350	192	+ 0.1%
18-8 Chromium Nickel	1,350	192	+ 0.1%
Plain Steel	1,700	48	+ 0.3%
18-8 Chromium Nickel	1,700	48	0.0%

*After corrosion scale was scraped off.

The above table showing ALUMICOAT protection, is a factual report of the protective capacities inherent in the application of this process to different metals at different conditions.

The Alumicoat Process has been successfully applied to Jet Aircraft Components, Petroleum Refinery Equipment, Exhaust Manifolds, Diesel Engine Components, etc. Full details of the Alumicoat Process will be furnished upon request.

ARTHUR TICKLE ENGINEERING WORKS, INC.

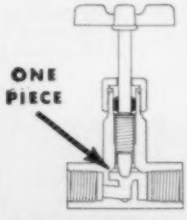
21-D Delevan Street • Brooklyn 31, New York • MAin 5-4200

New MARSH *Needle Valves*

MAXIMUM WORKING PRESSURE 10,000 PSI

. . . for finer regulation of water, oil or gas

First needle valve to combine all the characteristics called for in modern industry. Embodies sturdiest basic construction—machined from solid bar stock—suitable for pressures to 10,000 psi and equally efficient in lower range. Note stem guide fused to body by new "Conoweld" process, eliminating faults of conventional two-piece valves. Stem 416 stainless steel. Stem threads fine pitch for strength and micrometer regulation. Body electro-zinc plated. Sizes ⅛" to 1", globe and angle patterns.



Ask for new Needle Valve Catalog

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corp.* **Dpt. 39, Skokie, Ill**
Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd Street, Edmonton, Alberta, Canada

computing components are then described in detail, with attention to their inaccuracies, defects and shortcomings. Noteworthy is the inclusion of a number of newer, nonlinear components. Detailed descriptions of setting up analog computers for solving a number of specific problems are presented. These include road vehicle suspension, aeroplane flight with automatic control, a naval "battle" with ballistics, and motions of a charged particle in combined electric and magnetic fields. The book also describes and illustrates a number of existing computers, including Tridac, one of the biggest computers in the world.

Chemical Compositions and Rupture Strengths of Super-Strength Alloys

9 x 12 in., 8 pp. *Published by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.* $0.75.

Prepared by a task group of Subcommittee XII on Specifications for High-Temperature Super-Strength Alloys of ASTM Committee A-10, this list was to include "all super-strength alloys known to or used by the various industries, giving chemical compositions and available properties." Because mechanical properties mean little without the details of processing and heat treatment, only the 100 and 1000-hr rupture strengths have been given and these only to give an indication of the relative high-temperature strengths of the various alloys. Since most of the alloys listed are of a proprietary nature, the probable patentee has been listed.

Differential Equations

LESTER R. FORD, *Prof. Emeritus of Mathematics, Illinois Institute of Technology, 6¼ x 9¼ in., 291 pp. Published by McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y.* $5.

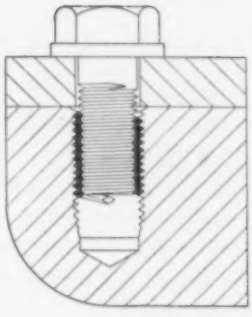
This new second edition is designed for readers seeking a text intermediate between the elementary books that emphasize the techniques of solving special types of equations and the advanced texts that presup-

(Continued on page 389)

STRONGER CLEANER LIFETIME THREADS

in lighter, softer, thinner materials

with HELI-COIL* Screw Thread Inserts



Heli-Coil Inserts, coils of stainless steel or phosphor bronze wire, produce superior internal threads that solve many design problems. Thousands of manufacturers are using them to greatly increase thread strength in light metals, wood, plastics; to stop corrosion, seizing and galling; and to increase thread life. In thousands of applications ***Heli-Coil*** Inserts now enable designers to use thinner materials, shorter thread engagements, lighter materials—to save space, time and money.

Send in the coupon today. You'll get samples and complete information.

***Heli-Coil* Inserts conform to official Military Standards MS122116-122275(ASG), MS124651-124850(ASG) & MS33537(ASG)**

*Reg. U.S. Pat. Off.

HELI-COIL CORPORATION
161 Shelter Rock Lane, Danbury, Conn.

☐ Send samples and Design Manual 652A.
☐ Send samples and Military Standards Manual 689A.
☐ Please have a *Heli-Coil* Thread Engineer call.

NAME_____TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ZONE____STATE_____ 3052

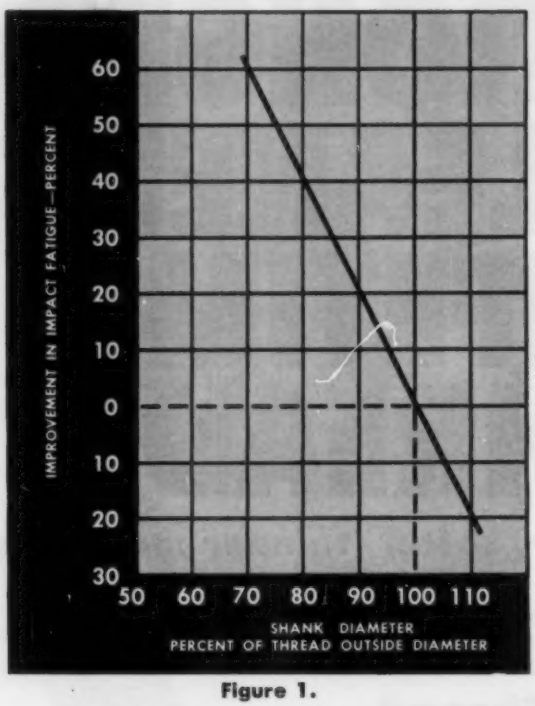


Figure 1.

24 page
engineering data...
Section

Figure 1, page 4 in the Engineering Section of our catalog—"Fatigue Strength is improved when the shank diameter of the bolt becomes less than the O.D. of the thread," is just one of the several factors that are discussed, on pages 3, 4, 5, and 6, in the applications of finished hexagon nuts, where highly stressed bolts of special material are required. . . . Fourteen topics, concerning the technique in the manufacture and proper installation of our product are covered in this twenty-four page brochure—requests for this literature will be handled promptly.

NATIONAL MACHINE PRODUCTS COMPANY

Manufacturer of Standard and Special 12 Pointer and Hexagon Nuts . . . "Huglock" and "Marsden" locknuts.

44253 Utica Rd., UTICA, Michigan

For Every Product from Gas Cylinders to Boats . . .

MEYERCORD

DECAL Nameplates do the job *BETTER!*

Your trade mark and brand name is one of your most precious business assets. Make sure your brand identification will be seen to the very best advantage by your customers and your prospects . . . make sure you always specify *Meyercord* Decals. Without obligation, let a *Meyercord* Sales Engineer show you how and why *Meyercord* Decals can do the job better for you.

FREE! "MARK-IT" MANUAL OF DECAL NAMEPLATES

Send today, on your company letterhead, for this valuable full-color guide to every industrial problem in marking, identification, instruction, and information. Gives you hundreds of new ideas for application of decals to your products.

THE MEYERCORD CO.

World's Largest Decalcomania Manufacturers

Dept. M-318, 5323 WEST LAKE STREET • CHICAGO 44, ILLINOIS

VULCAN

ELECTRIC HEATING UNITS

Vulcan Ring Heaters

The same standard construction as Vulcan cartridge and strip heaters. Coil of highest grade resistance wire is supported in and insulated from sheath by refractories of proven quality.

Easily installed by clamping against the surface of hot plates, pots, defrosters, vulcanizers, moulds, dies, water heaters, etc.

Rust-resisting sheath for temperatures to 750° F.

Stainless steel sheath for temperatures to 1200° F.

6 standard sizes

Special sizes available

VULCAN ELECTRIC COMPANY, Danvers 18, Mass.

EXPERIENCED SPECIALISTS IN ELECTRIC HEAT

Makers of Vulcan Electric Soldering Tools, Electric Solder Pots, Electric Branding Irons, Electric Heating Units

See 8-page Vulcan catalog in Sweet's Product Design File for 1955.

Endurance Rated
ELECTRIC COUNTERS
and ACTUATORS
to Fit every need

200,000,000 COUNT LIFE

PIC
SUPER-WIZARD

1000 CPM.
5 watts input.
Balanced Armatures.
4 and 6-digit models in basemount, panelmount and dustproof enclosed types for 60, 40-50, 25 cycles and DC; all voltages to 230.
Purchase cost only 18c per million counts.

50,000,000 COUNT LIFE

PIC
600

1000 counts per minute
7 watts power consumption
Balanced armature
Quiet operation. No AC hum.
Tamper proof housing.
Lubrication not required.
Available in basemount and panelmount models—also to count dozens, for 60, 40-50, 25 cycles and DC; all voltages to 150.

6,000,000 COUNT LIFE

PIC MERCURY
4-digit Reset

600 Counts per minute.
3 watts power input.
4-digit Basemount and Panelmount models also to count dozens — all voltages to 115, AC or DC.

3,000,000 COUNT LIFE

PIC MERCURY
5-digit non-reset

600 Counts per minute.
3 watts power input.
Tamper proof construction.

See your PIC Representative or write

PIC
PRODUCTION INSTRUMENT CO

702-10 W. Jackson Chicago 6, Illinois

pose a good deal of mathematical maturity. While the usual special methods are not neglected, they are fitted into a presentation in which the general points of view are emphasized.

The text covers ordinary and partial equations, including interpolation and numerical integration and the numerical solution of differential equations. The introductory chapters stress the geometric approach and elementary methods and lead gradually into the varied applications of the subject. These are followed by accurate statements and rigorous proofs of existence theorems reduced to their simplest forms. The latter constitute the foundation for the later methods of numerical solution. Laplace transforms are introduced and articles are included on elastic vibrations, planetary orbits, wave motion and the flow of heat. Additional methods of numerical solution are given, including that used in potential theory and the flow of heat. A complete set of problems and answers is also included in the book.

Radio Operating Questions and Answers

J. L. Hornung, *Hopkins Engineering Co., and* A. A. McKenzie, *Associate Editor, Electronics*, 5¾ x 8¼ *in.*, 571 *pp. Published by McGraw-Hill Book Co., Inc.*, 330 W. 42 *St.*, New York 36, N. Y. $4.50.

This volume brings up to date a book that has been an old standby for over a third of a century to aid in preparation for government examinations for commercial radio operators' licenses of all types.

As in earlier editions, the questions are those found in the booklet: "Study Guide and Reference Materials for Commercial Radio Operator Examinations," published by the FCC and available from the Superintendent of Documents, Government Printing Office, Washington, D. C. It should be recognized that this book is not a radio or electronics text and that such books may be needed to supply a full understanding of the answers given. The actual examination questions are of the multiple choice type, which precludes the possi-

(Continued on page 390)

FOR LARGE OIL SEALS
IN SMALL QUANTITIES
AT THE LOWEST COST SEE

Universal

Universal's unique manufacturing method which eliminates tooling charges for unusually large diameter oil seals is ideal for experimental and small quantity orders.

Precision-built to give long, efficient, trouble-free service—all Universal Oil Seals 'specially engineered for floatability, self-alignment and automatic take-up.

Oil seals for every purpose!

UNIVERSAL
OIL SEAL CO.
P.O. BOX 74
PONTIAC, MICH.

TURN YOUR OWN PINIONS

Mass Gear can generate spur, helical and worm pinion rod in all types of material including plastic.

Mass Gear can also produce any type of serrated or special form rod that can be generated.

These rods are available up to 6 feet in length, from 5/32" to 1 ¼" in diameter.

Mass Gear products are made to A.G.M.A. standards, thus insuring uniform quality.

Illustrated brochure showing interesting designs and suggestions available upon request.

Massachusetts Gear & Tool Co.
WOBURN, MASS.

X-Y PLOTTER
AND RECORDER
RECORDS
TWO INDEPENDENT
VARIABLES FROM
ANALOG OR DIGITAL
INPUTS
A compact, desk-size unit designed for general purpose graphic recording from analog or digital inputs with standard Librascope converters or special modifications engineered to customer requirements. Unique pen travel, fast and dependable. Full chart visibility allowing curve generation to be observed at all times. Write for detailed catalog information.
Mechanical and electrical analog computers, digital computers, input-output devices and components.
Computers and Controls
LIBRASCOPE
LIBRASCOPE, INCORPORATED
1607 FLOWER ST., GLENDALE, CALIF.

bility of passing an examination by a strict memorization of the answers.

Elements 1 and 2 are completely revised, and new questions have been added to elements 3 and 4 as required. Questions on transistors and color television are included for the first time.

American Standard System for Straight Bevel Gears

8½ x 11 *in.*, 9 *pp*, *paper-bound. Published by American Society of Mechanical Engineers, 29 W. 39 St., New York 18, N. Y.* $1.

This system (ASA B6.13-1955) for the design of straight bevel gears is a development from a system originated by the Gleason Works and adopted by the AGMA in 1922 and revised in 1940. Changes made in the present revision (1955) are: (1) slight increases in clearance and whole depth which are proportionately greater in the case of fine-pitch teeth; (2) somewhat different proportional tooth thicknesses of pinion and gear for approximately equal strength as determined by improved methods of analysis and design; and (3) adoption of 20 deg as the pressure angle, instead of 14½ deg as previously. Information regarding angular gears is added.

The text pages described the general basis of the system and show the calculations used to obtain the tooth proportions and blank dimensions. This Standard was prepared with the cooperation and approval of the AGMA Bevel Gearing Committee. It was presented to ASA Sectional Committee (B6) on the Standardization of Gears by its Subcommittee on Straight Bevel Gears.

Handbook of Acoustic Noise Control

Wright-Air Development Center, Wright-Patterson Air Force Base, 8 x 10½ in., 308 pp, paper-bound. Available from U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C. $8.

This publication is a revision of and supplement to Vol. I, prepared for the Aero Medical Laboratory, Wright Air Development Center. Vol. I and

(Continued on page 391)

its supplement treats the generation and control of various types of noise sources. Vol. II analyzes the interaction between noise and man and is in the process of being supplemented.

The supplement begins with Chapter 4 which is a review of the generation of aircraft propeller and reciprocating engine noise. Subsequent addenda are made to Chapter 6 on noise generation in axial flow compressors and ventilating fans and to Chapter 11 on insulation and transmission of impact and airborne sound. In Chapter 12 the specification of sound absorptive properties is covered in a detailed and careful analysis. Sound transmission and absorption in lined ducts and the acoustical shielding by structures are also described in this Chapter.

It should be understood that this supplement is meant to correct and amplify Vol. I of this report and is not intended to be used alone; however, within its coverage, it gives a very complete mathematical description of the various phenomena involved.

Electronic Circuits

THOMAS L. MARTIN, JR., Prof. of Electrical Engr. and Head of Dept. University of Arizona. 6 x 8¾ in., 707 pp. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y. $12.

This new book offers a systematic method of formulating electronic circuits. The method is largely independent of whether the electronic component is a vacuum or gas tube, transistor or magnetic amplifier. Well-known principles of circuit theory are shown that apply to any electronic circuit, so that electronic circuit design is reduced in a simple way to ordinary circuit design.

A Professional Look at the Engineer in Industry

6 x 9 in., 124 pp, paper-bound. Published by National Society of Professional Engineers, 1121 Fifteenth St., N.W., Washington 5, D. C. $3.00; NSPE members, $1.50.

Many questions plague the average engineer about his status as a professional employee and each individual must sooner or later find his own answer about his place in industry and

(Continued on page 393)

MIDLAND
WELDING NUTS
...Make Tough Jobs Easy!

SAVE TIME!
SAVE TROUBLE!
SAVE MONEY!

If you've got a product involving metal fabricating, fastening or assembling, chances are you can use Midland Welding Nuts to big advantage.

They come in all sizes for every-sized job. Welded to the part or parts concerned, they don't have to be held while bolts are turned into them. Thus one man can often do the work of two.

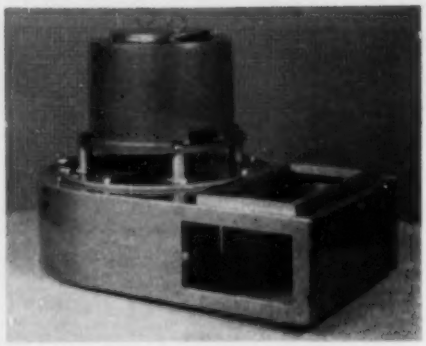
And they're indispensable when it comes to those tucked away, hard-to-get-at places. Welded in advance to those inside spots where it is difficult—or *impossible*—for hands or tools to reach, Midland Welding Nuts hold fast while bolts are turned into them.

If you're a designer, you'll want to know about these time and labor-savers, too. Midland Welding Nuts will solve and simplify many of *your* problems, too.

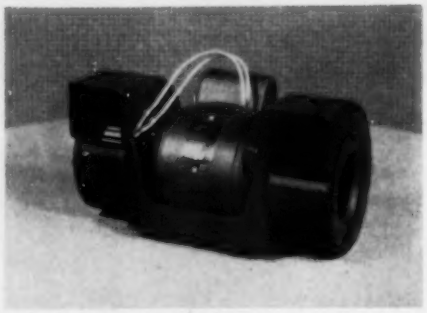
Write or phone for complete information!

The MIDLAND STEEL PRODUCTS COMPANY
6660 Mt. Elliott Avenue • Detroit 11, Michigan
Export Department: 38 Pearl St., New York, N. Y.
Manufacturers of
Automobile and Truck Frames • Air and Vacuum Power Brakes
Air and Electro-Pneumatic Door Controls

COMPACT
Peerless® Blowers for OEM Applications



DIRECT DRIVE blower equipped with space saver motor. Custom-built by Peerless for high pressure, big volume air delivery. Designed to customer's specifications.



TWIN BLOWERS for use in electronic equipment. Built to customer and government specifications. Protected against fungus and high temperatures.

● Practical experience and complete production facilities at Peerless Electric help us solve equipment cooling problems quickly and efficiently. We work with many of the nation's top producers of electronic equipment. We design and build our own motors. We design, engineer and build our own fans and blowers. From start to finish we have complete control of our products. Let our engineers tackle your equipment cooling problems. We will work to your size restrictions and give your fans or blowers the capacities and qualities that make your equipment operate best.

WRITE FOR PEERLESS BULLETIN SDA-160

FAN AND BLOWER DIVISION

THE Peerless-Electric® COMPANY

FANS · BLOWERS · ELECTRIC MOTORS · ELECTRONIC EQUIPMENT
1406 W. MARKET ST., WARREN, OHIO

ROTATING or STATIONARY ASSEMBLIES
held together EASIER with

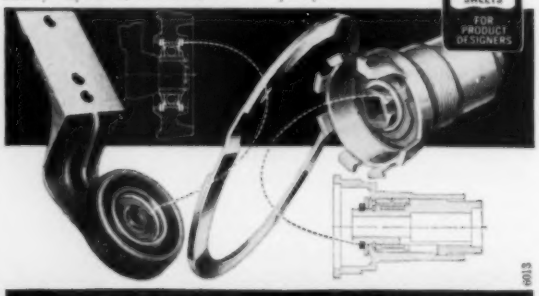
SpirOlox Retaining Rings

Conveyor roller application at left shows how Spirolox attains neat, compact, simplified design, even on rotating assemblies. Stationary application of lock assembly illustrates how Spirolox can be applied to hard-to-reach places where retaining ring must operate in very confined space. Secret of Spirolox adaptability is patented *two-turn* construction, which makes possible unique locking characteristic... will not jump out of groove. Always provides a uniform shoulder... no lugs, no gap.

FREE DATA BULLETIN
Send blueprint of your retaining problem. Ramsey Corporation, St. Louis 8, Mo.

U. S. Pat. No. 2,450,425 and Foreign Pats. Other pats. pend.

SEE OUR CATALOG IN SWEETS FOR PRODUCT DESIGNERS



Rotating or Stationary

SPIROLOX—the Better Way to Hold Moving Parts TOGETHER!

WESPO for ALL WORK-HOLDING needs!

TOGGLE CLAMPS
35 Types & Sizes

Note These Features—Reamed Holes—Hardened Serrated Bushings—High Tensile Strength Rivets

STANDARD FIXTURE CLAMPS
15 STYLES . . . 136 SIZES

COMPONENTS
Over 1000 different Types & Sizes available from stock.
Write NEW TEMPLATE for CATALOG

WEST POINT MFG. CO.
26935 W. 7 Mile Road, · Detroit 19, Michigan

in the surrounding economic climate. Often decisions are reached as a result of pressures brought to bear by an immediate employer, an eloquent associate or a persuasive newspaper columnist. Certainly the limited view of any one of these sources is inadequate when one considers the importance of these questions and the complexity of the situation creating the need for practical solutions.

Rival claims for unionism and professionalism have often seemed to eliminate the possibility of a middle road for the professional employee. The older unions and the National Labor Relations Act, better known as the Wagner Act, tended to ignore basic differences between professional employees and the larger group of skilled and unskilled labor. As a result, a policy statement of the NSPE declares: "It is definitely unprofessional for a professional engineer, professionally employed, *voluntarily* to join a heterogeneous labor union, dominated by, or obligated to, nonprofessional groups."

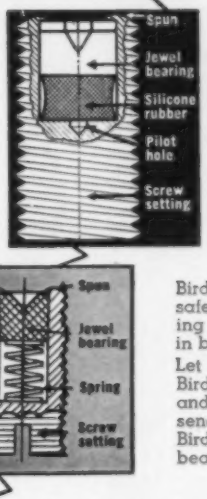
However, organization has been the keynote of the current industrial age. There are between 75 and 100 national engineering organizations covering different branches, fields of interest, types of service, areas of employment, and even branches within branches. No single component can deal effectively with the major problems and so the Engineer-in-Industry Committee of the NSPE has prepared this report to discover the means and methods whereby the interests of this employee group can be defined, recognized and treated.

A review of the history of engineers and unions is important to a proper understanding of the current situation and indispensible when plans for future action are under consideration. In this book, an analysis of the Wagner Act, its important implications and some sample case decisions make clear the provisions which affected engineers at the time and describes the trend of opinion evident in the National Labor Relations Board.

Serious limitations in the Wagner Act resulted in a unified campaign on the part of the professional societies to modify the law by permitting professional employees to refuse membership in a collective bargaining unit unless a majority of professional em-

(Continued on page 395)

Be SURE of SHOCK PROTECTION for delicate instrumentation



Pennies invested
Thousands saved

Bird jewels with resilient silicone rubber or spring cushions provide inexpensive shock resistance for any instrument. Bird provides variable cushioning to suit different operating conditions; mountings to any specification; controlled movement of jewel.

Bird Cushion Jewel Assemblies add the necessary safety factor to your instrument production, eliminating waste and tear-down because of poor judgment in bearing adjustment.

Let actual tests prove the superb performance of Bird Cushion Jewel Assemblies. Send specifications and sizes of jewel bearings you require. Bird will send you samples for testing in your own plant. Bird engineers are available for all your small bearing problems.

Over 40 years of serving industry with Quality jewel bearings

Richard H. Bird & Co., Inc.

Sapphire and glass jewels Precision glass grinding Jewel mounting and assembly Sapphire styli

20 Spruce Street, Waltham 54, Mass.

YOUR PRODUCT DESERVES THE BEST

US RADIUM

Consultation – Design – Engineering – Production

These services are available to you on all applications involving use of

PANELS — DIALS — NAMEPLATES — SPECIALTIES

Screening • Lithography • Etching • Engraving
Photographic Reproduction – LACKON – MIL-P-7788

RADIOACTIVE SOURCES — LUMINESCENT MATERIALS — PROCESSED ISOTOPES —

Sealed Sources • Radiations Standards • Radioactive Foils • Safety Markers
Self-Luminous Compounds • Luminous Markers • Radium Products • Light Sources
Neutron Sources • Radiographic Sources • Light Standards • Radioactive Batteries
Ionization Sources • Ionotron Static Eliminators

PHOSPHORS — X-RAY SCREENS

Television Phosphors • Phosphorescent Powders • Fluorescent Powders

for further information address Dept. PE-1

UNITED STATES RADIUM CORPORATION

Eastern Sales Office: 535 Pearl Street, New York 7, N. Y.
Western Sales Office: 5420 Vineland Ave., N. Hollywood, Calif.
European Sales Office: 36 Chemin Krieg, Geneva, Switzerland
Plants at: Bloomsburg, Pa., Bernardsville, N. J., Whippany, N. J., N. Hollywood, Calif.

MAIL THIS REQUEST TODAY

Sparta reports on

TEFLON

CUSTOM MOLDING IN THIN SECTIONS

an important new material for process industries with graphic illustrations and samples.

FIRM: _____

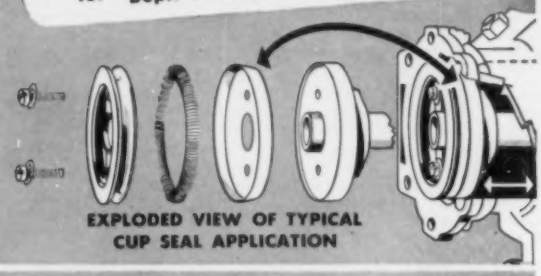
ADDRESS: _____ STATE: _____

CITY: _____

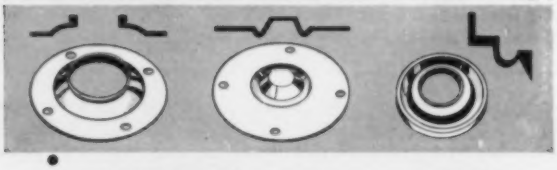
NAME: _____

POSITION: _____

Send to: SPARTA MANUFACTURING CO. Dept. PE "Tefseal" DOVER, OHIO



EXPLODED VIEW OF TYPICAL CUP SEAL APPLICATION



TEFLON'S unique properties

combined with our technique of custom molding TEFLON in thin sections and shapes, offer important advantages in product design.

- If you have a part now made of a flexible material which will not withstand severe conditions of temperature or corrosion, TEFLON is the answer. TEFLON is chemically inert . . . heat resistant (500° F or a −100° F) . . . has a very low coefficient of friction . . . does not absorb moisture.

Our trained engineers will work with you on any application of TEFLON Cup, Ball or Shaft Seals, Washers, Gaskets or Diaphragms to meet your exact requirements.

TEFSEAL SPARTA TEFSEAL

The first cost can be the least if it is the last cost

SPARTA MANUFACTURING CO. DOVER, OHIO Phone: 4-2755

he's working for you

THIS FELLOW IS TRAINED IN YOUR BUSINESS. His main duty is to travel the country — and world — penetrating the plants, laboratories and management councils . . . reporting back to you every significant innovation in technology, selling tactics, management strategy. He functions as your all-seeing, all-hearing, all-reporting business communications system.

THE MAN WE MEAN IS A COMPOSITE of the editorial staff of this magazine. For, obviously, no one individual could ever accomplish such a vast business news job. It's the result of many qualified men of diversified and specialized talents.

AND, THERE'S ANOTHER SIDE TO THIS "COMPOSITE MAN," another complete news service which complements the editorial section of this magazine — the advertising pages. It's been said that in a business publication the editorial pages tell "how they do it"—"they" being all the industry's front line of innovators and improvers—and the advertising pages tell "with what." Each issue unfolds an industrial exposition before you—giving a ready panorama of up-to-date tools, materials, equipment.

SUCH A "MAN" IS ON YOUR PAYROLL. Be sure to "listen" regularly and carefully to the practical business information he gathers.

McGRAW-HILL PUBLICATIONS

ployees vote for inclusion. The Taft-Hartley Act included this provision as well as a definition of the term "professional employee" which had been derived from a similar definition established by the administrator of the Wage-Hour Act.

Considerable opposition still remains to the provisions and definitions in the Taft-Hartley Act as they affect professional employees. In particular, the unions resent the freedom from control permitted by law. Taft-Hartley is still and will continue to be the center of controversy every time Congress meets. The Engineer-in-Industry Committee finds from a study of cases that the NLRB performed a difficult task in administering the law with commendable objectiveness and common sense designed to give the principle of voluntary professional separation the most liberal application.

Having established the background and current legal status of professional employees, the Committee goes on to describe their causes of dissatisfaction which seem to narrow down to lack of proper engineering-management communications, utilization of engineering manpower, economic remuneration, and professional treatment. A brief review of engineer salaries over the past thirty years.

That professional engineers have cause for complaint seems unquestioned. The best course of action to repair these errors, however, forms the bone of contention between professionalism and unionism. In the middle of the struggle stand the thousands of engineers, many of whom are confused and uncertain in their attempt to achieve both economic advancement and professional growth. Surveys indicate that only about a third of the working engineers believe their interests are strengthened by membership in a collective bargaining organization.

The middle ground is represented by groups of engineers who contend that in large organizations it is unrealistic to expect individual personal relations between the professional and management. Some form of organization, of communication, is needed and these have become known as "sounding board organizations" or "non-bargaining organizations." The exact classification of these groups is difficult to determine and this confusion has limited their effectiveness.

FILTER FORUM

New publication by Purolator is the first comprehensive filtration guide ever edited specifically for designers

Question:

Where can a designer find all the answers to his filter problems?

Where can filters be used profitably? When should they be used? How do filters save money? What are the facts about degree of filtration, flow rate, contamination to be removed, viscosity of fluid? These are questions that continually come up in design work. But, up to now, no handy, authoritative source has been available for the designer's files.

Answer:

Purolator's new "Filtration Manual for Product Designers"

Now, for the first time, Purolator's new manual gathers all the answers in one place and makes them available to the product designer. "Filtration Manual for Product Designers" spells out application considerations in detail and includes a complete glossary of terms that apply to filtration. Here are some typical section headings:

	PAGE
WHY ARE FILTERS USED	4
WHERE FILTERS ARE USED	6
PLANNING FILTRATION IN ADVANCE	8
FILTRATION ENGINEERING	10
How filters are applied	10
Glossary of filtration terms	16
How Purolator filters are made	18
WHERE THE DESIGNER CAN SELECT A FILTER	22
Gasoline engine lubrication	23
Tank and crankcase breathers	23
Air intake for engines and compressors	23
Hydraulic fluid	24
Machine tool coolant	25
Bulk fuel handling	26
Diesel engine fuel	28
Diesel engine lubrication	28
Fuel oil burner	29
APPLICATIONS THAT CALL FOR SPECIALIZED STUDY	30

PUROLATOR

FIRST in the field of filtering

MAIL THIS COUPON FOR YOUR COPY

Dept. D7-129, Purolator Products, Inc., 970 New Brunswick Ave., Rahway, N. J.

Please send me the following:

_____ Copy of "Filtration Manual for Product Designers". I'm including 25¢ to cover postage and handling.

_____ Enclosed is a description of our filter problem. How should we solve it?

NAME _____ TITLE _____

COMPANY _____ ADDRESS _____

CITY _____ ZONE _____ STATE _____

here's what We mean by a

COMPLETE LINE

Our new catalog of Standard Threaded Products lists over 4000 items carried in stock to be shipped out to you within 24 hours—often sooner!

FOR ANY PURPOSE

IN ANY SIZE

IN ANY QUANTITY

...from a package to a carload

Our maintaining such large stocks of all 4000 items means lower costs to you because no large inventories are needed, service is faster. Our better methods of manufacture produce a higher quality product. Good reasons why so many industrial users in the last 83 years have come to specify "Chicago" Screws.

Service-Conscious Industrial Supply Distributors EVERYWHERE carry complete stocks of "Chicago" Products. To speed delivery time, call the one nearest you.

406

CHICAGO SCREWS

The CHICAGO SCREW COMPANY
ESTABLISHED 1872
2607 Washington Boulevard
Bellwood, Illinois

The complete Chicago "Safety Plus" line includes in alloy steel: Socket Set Screws • Socket Head Cap Screws • Socket Stripper Bolts • Square Head Dog Point Set Screws • Socket Pipe Plugs • Flat Head Socket Cap Screws • Dowel Pins • Hexagon Keys and Key Kits • Also Socket Set Screws and Socket Head Cap Screws in Stainless.

The complete "Chicago" line of Standard Products includes: Hexagon Head Cap Screws in steel—bright and Grade 8, heat treated, also in brass and stainless • Square Head and Headless Set Screws • Taper Pins • Steel Studs • Flat and Fillister Head Steel Cap Screws • Hexagon Nuts in steel, brass and stainless • Castle Nuts, steel.

THIS IS A DUCT BELL

Here is another example, proving that Universal porcelain engineers can economically develop an insulator for keeping electrical circuits safe.

If complicated designed insulators are a problem to you, just send your specs to Universal. Our experience and manufacturing facilities may be what you need.

THE UNIVERSAL CLAY PRODUCTS CO.
1545 EAST FIRST STREET (U) SANDUSKY, OHIO
TRADE MARK

12 REASONS WHY...

Bendix* Electric Fuel Pump performs better . . . lasts longer!

1. Performance-proven
2. Longer Life • No Pressure "Droop"
3. Dependable Operation at −75°F.
4. Improves Low-Temperature Starting
5. Built-in Pressure Release
6. Eliminates Vapor Lock
7. More Gallons per Hour
8. Easy to Install and Service
9. Low Power Requirements
10. Economical Operation
11. Light Weight • Compact
12. Rugged • Tamper-proof

Learn more about this new and improved fuel pump. Write for descriptive folder and specifications.

ECLIPSE MACHINE DIVISION ELMIRA N. Y. Bendix AVIATION CORPORATION

*REG. U. S. PAT. OFF.

OUR READERS SAY . . . . . .

Letters should be addressed to The Editor, *Product Engineering*, 330 West 42nd St., New York 36, N. Y.

Reference Correction

To the Editor:

In the November, 1955, issue you have added an "Editor's Note" to "Designing Snap-Action Toggles" by Erwin F. C. Schulze. We would like very much to see the reference you have mentioned there but cannot find an article entitled, "Toggle Linkage Applications in Different Mechanisms", by Thomas P. Goodman in the November, 1949, issue of *Product Engineering*. Could you please let me know the correct reference as soon as possible? —JUNE E. NORRIS
Harrisburg, Pa.

Ed—Through a typographical error the article "Toggle Linkage Applications in Different Mechanisms" was listed as appearing in our November, 1949, issue. Actually, this article appeared in our November, 1951, issue.

Way Guard Stays Put

To the Editor:

Thank you very much for the copy of your November issue, containing information about various machines exhibited at the Machine Tool Exhibition in Chicago.

Unfortunately your reporter apparently did not get the correct picture on our spring steel way guards shown on page 132, since the main advantage of these guards is that they do not roll and unroll as is indicated in your description, but actually are one straight strip attached to each end of the machine base. The strip is picked up by a roller underneath the table as the table traverses. The strip then passes through a cored hole in the table, as outlined in the rough sketch we are attaching.

Your report is unfortunate because the main advantage of our guards is the fact that they do not roll and unroll. In most cases where such an ar-

(Continued on page 399)

THIS EXCLUSIVE BUSHING PRESENTS NEW DESIGN OPPORTUNITIES!

WHITNEY SELF-LUBRICATING ROLLER CHAIN FOR IMPORTANT SAVINGS —LONGER CHAIN LIFE

A new and exclusive Roller Chain with *built-in* lubrication . . . a product of Whitney Chain research. High strength, oil-impregnated sintered steel bushings oil from the *inside* . . . make chain drives practical and profitable where lubrication cannot be applied, or where normal lubrication may contaminate products in process.

Typical applications include textile, tobacco and food processing machinery, or wherever products must be isolated from lubricants. Here, Whitney Self-Lubricating Chain cuts production costs, gives chain service life far beyond that of non-lubricated chain and is completely interchangeable with American Standard Roller Chain of the same pitch.

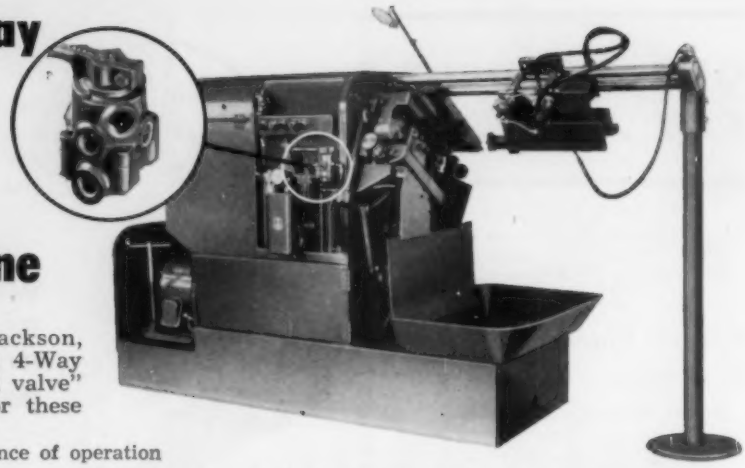
Get the facts on this revolutionary development in the Whitney Self-Lubricating Chain Folder covering case histories, wear and impact tests, strengths and sizes available.

WHITNEY ENGINEERING SERVICE

Consult your nearby Whitney Field Office on any of your drive problems. Whitney's complete line of Roller, Silent, Conveyor Chains and Sprockets enables our technicians to help you determine the chain best suited to your requirements.

Whitney
CHAIN COMPANY
204 HAMILTON STREET, HARTFORD 2, CONNECTICUT

NOPAK Dual 4-Way is Main Air Control on "Modern" Cutting-Off Machine



Modern Machine Tool Co., Jackson, Mich., uses the NOPAK Dual 4-Way valve as the "main air control valve" on its Cutting-Off Machine for these reasons:—

1. It provides the necessary sequence of operation control.
2. It is "easily mounted . . . in readily accessible position".
3. It directs air pressure either to part of the air system, or the whole system, as required.
4. With valve lever at 45°, "the operator can set the tools, with a gauge, against the stock while it (the stock) is locked in the collet".
5. In normal running position with valve lever at 90°, air is directed to other parts of system, while maintaining pressure on collet cylinder during cutting cycle.

This application may suggest how you can use NOPAK Valves and Cylinders for effective control and application of fluid power in your product, or in your plant equipment. For other suggestions see the NOPAK Application Manual.

Write for Latest Shelf-Stock Listings

GALLAND-HENNING NOPAK DIVISION
2762 SOUTH 31ST STREET • MILWAUKEE 46, WISCONSIN

Representatives in Principal Cities

NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

CAN YOU USE COLD MOLD METAL

For:
- Fixtures
- Laminations
- Prototypes
- Build-Ups
- Core Boxes
- Holding Jigs
- Embossing Dies
- Mold Repairs
- Vacuum Molds
- Match Plates

Other Uses

Here is a new aluminum compound that promises to simplify many production procedures. It's a free-flowing metal that casts cold yet hardens solid at room temperatures without heat or pressure. Cold-Mold is simple to use. Intricate jigs, dies, patterns and other parts and tools can be formed as easily as plaster is poured. The hardened metal is dimensionally stable, may be worked with ordinary tools and plated with other metals.

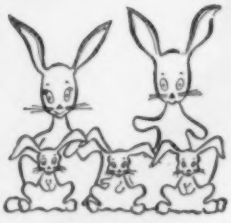
See for Yourself

We can't begin to know all the jobs Cold-Mold can do; but perhaps our technical bulletin will suggest applications in your field.

WRITE,

the sculp-metal company
701-3 Investment Bldg. Pittsburgh 22, Pa.

IT TAKES TWO



DISPLAY ADVERTISING
- Arouses Interest
- Creates Preference

DIRECT MAIL
- Gets Personal Attention
- Triggers Action

After your prospect has been convinced by DISPLAY ADVERTISING, he still must take one giant step. *He must act.* A personalized mailing piece direct to his desk, in conjunction with a display campaign, is a powerful action getter.

McGraw-Hill has a Direct Mail Division ready to serve you with over 150 specialized lists in the Industrial field.

To get your copy of our free INDUSTRIAL DIRECT MAIL CATALOGUE (1954) containing complete, detailed information about our services, fill in the coupon below and mail it to McGraw-Hill.

Do it now! The best advertising programs are planned well in advance.

Direct Mail Division,
McGraw-Hill Publishing Co., Inc.
330 West 42nd St., N. Y. 36, N. Y.

Please forward my free copy of the McGraw-Hill "Industrial Direct Mail Catalogue."

Name_____

Company_____

Address_____

City_____ State_____

rangement is employed it permits the dirt to be transferred from the outside of the guard to the inside, and then deposited on the supposedly guarded ways. In our case, the top of the guard remains on top all the time, eliminating transference of grit or dirt to the ways. —R. D. LAWSON
Worcester 6, Mass.

Ed–Thank you for bringing this error to our attention. The accompanying sketch of the Norton Co.'s steel way

guard should help to correct any misunderstanding of this device which the report in our September issue may have caused.

Sources of Back Issues

To the Editor:

Would you kindly send us the back issues of your publication listed below?

1) November 1950
2) March, April, June, September 1951
3) March 1952
4) April, July 1953

If any of these are not available from your office, please advise us where we might be able to obtain them. —WILLIAM LACY
Dallas, Texas

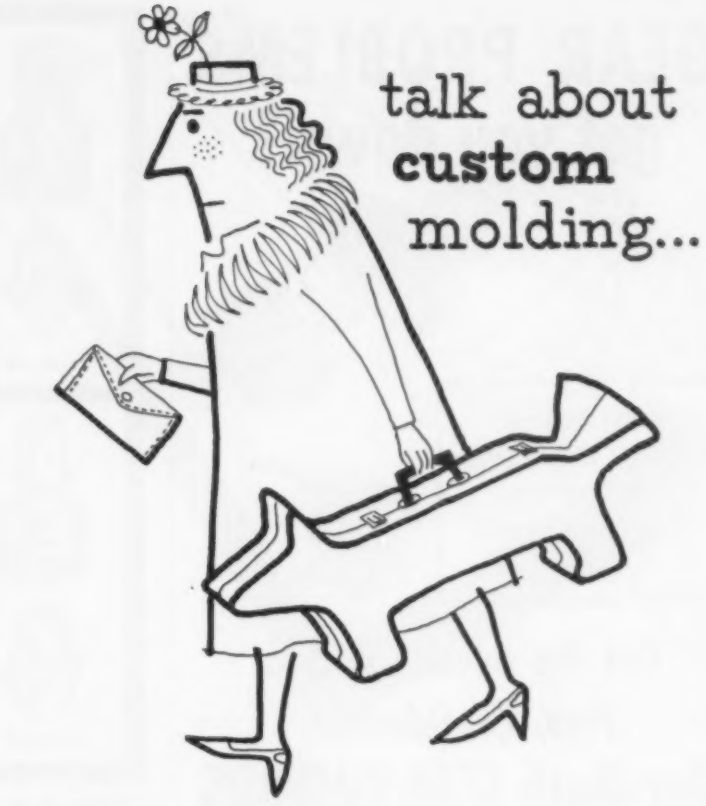
Ed–We are unable to supply you with any of the issues of *Product Engineering* listed. We keep back copies for only one year, but one of the companies listed below who deal in back issues of our publication may be able to supply you with the copies you are seeking.
Kraus Periodicals, Inc., 805 Mamaroneck Ave., Mamaroneck, N. Y.; J. S. Conner, 909 Boylston St., Boston 15, Mass.; Rockingham Co., Newmarket, N. H.

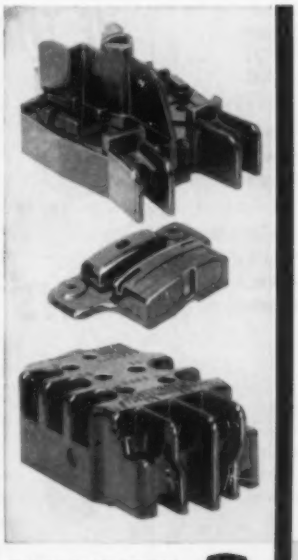
Extra Copies of Articles

To the Editor:

Almost every issue of *Product Engineering* contains at least one article that I would like to retain in

(Continued on page 401)





In plastics too . . . the easiest answer is to surround your problem with "know how" and then shape it to fit. If your parts can be molded in one of the tried and true thermo-setting plastics or the newer fluoro-carbons and glass-reinforced materials, flexible Kurz-Kasch can bend "know how" like a pretzel and come up with dependable custom-molding. Name the service you need . . . designing, moldmaking, production runs . . . it's all under one roof . . . at Kurz-Kasch. And talk about pretzels . . . here, they bend over backwards to help straighten you out. Let's talk it over, O. K?

BRANCH SALES OFFICES

New York, Mt. Vernon..MO 4-4866
Rochester .....E. Rochester 941
Chicago .....Merrimac 7-1830
Detroit .....Jordan 6-0743
Philadelphia .....Hilltop 6-6472
Dallas .....Logan 5234
Los Angeles .....Richmond 7-5384
St. Louis .....Parkview 5-9577
Atlanta .....Exchange 0414
Toronto, Can. .....Riverdale 3511
EXPORT OFFICE (N.Y.C.)
89 Broad St. Bowling Green 9-7751

SPECIALISTS IN THERMO-SETTING PLASTICS FOR 40 YEARS.

kurz-kasch

1415 S. BROADWAY, DAYTON 1, OHIO

GEAR PROBLEMS got you down?

Noise? Vibration?
Early Wear? Difficult Design?
Unsatisfactory
machine performance?
High cost?

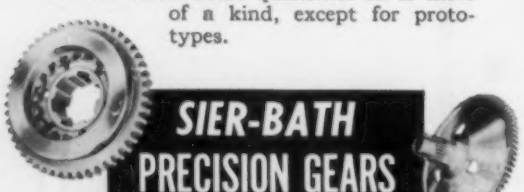
Get the solution with a *Free, Confidential* *Sier-Bath* GEAR DIAGNOSIS

With today's frequent advances in gear producing and gear testing machinery, making good gears has become as specialized as making ball bearings.

Sier-Bath has helped many leading machine builders with their gear problems. Everyone who has approached us with gear problems has always left minus the problems.

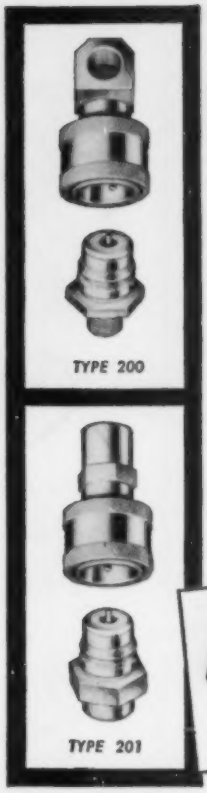
Take advantage of Sier-Bath's unsurpassed experience and facilities in the design and production of your gears. Learn for example, how you can have ground tooth gears at prices comparable to unground gears . . . or cut your costs, if that is your only problem.

Write us your gear problem for diagnosis—or request a Sier-Bath gear specialist to call for discussion at any appointed time, without charge or obligation, on a strictly confidential basis. Usual quantities 12 or more of a kind, except for prototypes.



SIER-BATH PRECISION GEARS

Sier-Bath GEAR and PUMP CO., Inc.
50th Anniversary 9238 Hudson Blvd., North Bergen, N. J. Member A.G.M.A.
Mfrs. of Precision Gears, Rotary Pumps, Flexible Gear Couplings



TYPE 200

TYPE 201

NEW miniature

QUICK-DISCONNECT COUPLINGS

Eastern's new couplings are the smallest available for high pressure systems. The lightest weight coupling made, Eastern units are used in pneumatic systems, and fluid systems such as hydraulic, and high pressure fuel.

SIZE: 2 3/16" overall length, .95" diameter

WEIGHT: 1.24 oz. (type 200); 1.17 oz. (type 201)

PRESSURE: 1500 p.s.i., maximum operating

FLOW: ½ g.p.m., normal

For detailed catalog sheet, write today.

Eastern INDUSTRIES, INC.
100 SKIFF STREET
HAMDEN 14, CONN.

IF THIS IS YOUR PROBLEM

If you need effective, highly readable, smartly illustrated company literature (booklets, pamphlets, manuals) to display your products, inform the public of your operations, attract key personnel to your plant, train employees, and perform any of the other communicative functions that are vital to your business . . .

THIS IS YOUR ANSWER

The McGraw-Hill TECHNICAL WRITING SERVICE has a staff of more than 150 highly-trained writers, editors, and illustration specialists whose job it is to create technical and general literature for industry. We write, illustrate, design, and print Equipment Manuals, Product Bulletins, Handbooks, Company Histories, Annual Reports, and other specialized material. Save money and time. Let our staff be your staff for Technical and Business publications.

This service is available through ad agencies.

Write • Phone

TECHNICAL WRITING SERVICE
McGraw-Hill Book Co., Inc.
330 W. 42nd St., N. Y. 36, N. Y.
LOngacre 4-3000

loose-leaf form for my own specialized notes on consumer product development. First of all, let me say how much I enjoy the meaty content of the magazine.

Second, may I ask what is your policy regarding charges for reprinted articles, either singly or in quantities, where there may well be a request coming in every month? Are reprints available for back issues? How far back?

Finally, there are two articles in the May, 1955, issue of which I would like reprints if available: "Kinematic Concepts that Simplify Design" and "Sheet Metal Fabrication".

Can do? —James Warren
Oshawa, Ontario, Canada

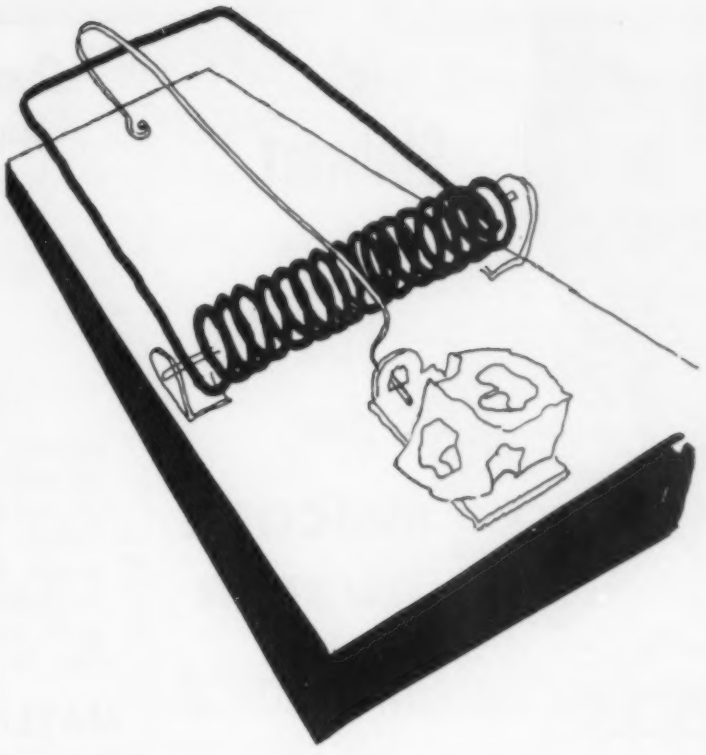
Ed–Although we did not make reprints of the two articles listed in your letter, we are enclosing tear sheet copies which we hope will be equally useful to you.

In answer to your other question, we maintain a tear sheet file of articles in current issues. Single tear sheet copies are available at no charge as long as our supply lasts.

MARCH OF DIMES

FIGHT INFANTILE PARALYSIS

JANUARY 3-31



Many **GOOD** *product could be made* **BETTER**

...with (B) Special Fasteners

IT CAN PAY YOU to take a new look at the fasteners you are now using. Designing Circle B specials into products often results in production economies, less assembly time, fewer parts to assemble and a better product to market.

HERE'S EXPERIENCED AND PRACTICAL HELP THAT'S EASY TO USE... Buffalo Bolt Company maintains a staff to cooperate with manufacturers on special fastener problems.

Often your rough sketch, with a few specifications, can be engineered into a special fastener which will do the job. And, of course, we are always pleased to quote on fasteners of your own design.

Contact any of our offices. **BUFFALO BOLT COMPANY**
Division of Buffalo-Eclipse Corporation
NORTH TONAWANDA, N. Y.

• *3 convenient service centers*

WESTERN OFFICE	EASTERN OFFICE	CENTRAL OFFICE
Chicago	New York City	North Tonawanda
HArrison 7-2179	REctor 2-1888	JAckson 2400 (Buffalo)

Many **GOOD** *products can be made* **BETTER** *...with* (B) **SPECIAL FASTENERS**

let **Stalwart** show **you** how **SILICONE RUBBER** can cut fabrication costs!

Industry across-the-board is solving problems, and *cutting costs*, with Silicone Rubber Parts. From access door seals on research rocket planes probing the heat barrier . . . to gaskets for kitchen range oven doors, they are providing the answer. Time and again Silicone Rubber Parts are replacing costly metal constructions forced upon design engineers by the limited thermal stability of organic rubbers.

Because new compounds now retain desirable rubber-like properties at temperatures from −130°F. to +600°F., they play ever-increasing roles in the aviation, automotive, electrical and chemical industries.

STALWART is equipped to produce precision parts from a variety of Silicone Stocks to meet individual, S.A.E., MIL-G or MIL-R specifications.

Parts made from Silicone have excellent dielectric properties and resist compression set, weathering, ozone, oxidation, hot lubricating oils and many chemicals. They can be covered with (or bonded to) a number of synthetic or other materials to provide greater strength or wearing qualities. Let STALWART show you how Silicon Rubber can *cut* your fabrication costs.

6651-SR

STALWART RUBBER COMPANY

For complete information, write today for Catalog 56SR-3

MANUFACTURING PLANTS IN BEDFORD, OHIO AND JASPER, GEORGIA
MAIN OFFICES 166 NORTHFIELD ROAD, BEDFORD, OHIO

MAYLINE

***Durability*—is built into Mayline Metal Plan Files**

Electrically welded heavy gauge steel protects and supports your drawings. Special roller bearings and channels provide fingertip control of drawers.

Strength, durability, efficiency, ease of operation—all Mayline features. Protect your time and money investment in drawings. Use Mayline Metal Plan Files. See Your Local Dealer!

MAYLINE COMPANY
605 No. Commerce St., Sheboygan, Wis.

MAYLINE

MAYLINE

MAYLINE

MAYLINE

ARENS

Compact Control

For Remote operation of Dampers, Vents and Valves

Easy to install, low cost sector gear and pinion device with wire flexible control. Converts rotary motion to linear push-pull. 1½" travel. Occupies only 1¾" x 1¼" panel area. Requires only one nut for mounting. Write for information.

Write for Catalog
40 page illustrated Arens Remote Push-Pull Control Catalog. Write for it.

ARENS CONTROLS, INC.
2013 Greenleaf Street
Evanston, Illinois

NEW

The AMERICAN MACHINIST'S HANDBOOK

Edited by
RUPERT LE GRAND
Senior Associate Editor, *American Machinist*

Based upon earlier editions of
AMERICAN MACHINISTS' HANDBOOK
edited by Fred H. Colvin and Frank A. Stanley
1579 pp., 5⅛ x 8, 774 illus., $11.00

Here's the biggest news in years for machinists, toolmakers, apprentices, designers, engineers, inspectors—in fact *all* in the metalworking industry. Now you can have the on-the-job help of an *amazingly improved, fully up-to-date*, NEW AMERICAN MACHINIST'S HANDBOOK.

Long a highly-regarded working tool, this book now has been completely revised and modernized in every way to make it a 1955 practical companion for technical men. Whether it's in design and drafting—machining and forming methods—metal finishing—or other major phases of your work—your problem can be better answered, solved more quickly, easily, and dependably with the aid of the wealth of modern descriptions, practices, and data given in this book.

BIGGEST IMPROVEMENT IN NEARLY 50 YEARS!

80% rewritten
Rearranged to give more facts—easier reference.
Fully up-to-date
1579 pages
774 illustrations
45 big sections

The facts behind this monumental change

Think of the advances of recent years in metalworking in all its aspects—not only the normal development of better tools and techniques in an important industry, but also the further advances demanded by work on new materials and new design applications! *The growth in metalworking technology, standards, and practice has been tremendous* — faces every man in the field with a great need for new working information. To meet this urgent need, the NEW AMERICAN MACHINIST'S HANDBOOK has been created—fully abreast of today's practice—and given to you with the practical treatment and handy reference features that will make this the "bible" of the industry for many years.

Gives day-to-day help in your work

The NEW AMERICAN MACHINIST'S HANDBOOK is so concisely written, so logically arranged, so packed with facts, that you'll find it of almost daily use in your work. Look up in it questions, large and small, on layouts, feeds, speeds, tools, jigs, fixtures, materials, standards, tolerances, forming and finishing methods—hundreds of details of machine shop and drawing room practice. You'll find the authoritative answers that will mean time and money saved and better results in all your work. See for yourself—have the book at your elbow—consult it for 10 days at our risk. No obligation to keep it unless it meets your needs. Just mail the coupon below.

10 DAYS' FREE EXAMINATION

McGraw-Hill Book Company, Inc.
Industrial and Business Book Dept.
327 W. 41 St., N.Y.C. 36

Send me Le Grand's NEW AMERICAN MACHINIST'S HANDBOOK for 10 days' examination on approval. In 10 days I will send $11.00 plus few cents for delivery costs or return book postpaid. (We pay delivery costs if you send remittance with this coupon; same examination and return privilege.)

(Print)
Name .....
Address .....
City ..... Zone... State.....
Company .....
Position .....
For price and terms outside U.S., write McGraw-Hill Int'l., N.Y.C. PE-1

PRESS PREVIEWS

Industrial Automation Film Premiered

The first industrial motion picture describing the history, growth, concept, and future of automation has been produced by General Electric. "This Is Automation" defines its subject as "continuous automatic production," and traces the evolution of automation since its inception in the early 19th century.

The film marks the 10th anniversary of the G. E. More Power to America program, which is aimed to help increase the nation's standard of living and industrial productivity by stimulating broader, more efficient use of electricity in industry, in the community, and on the farm.

This film was produced principally to show how middle and small-size industries can improve their manufacturing operations by adopting at least one or more of the techniques that comprise automation. It was explained at the film premiere that these techniques are related to the basic manufacturing phases: automatic making, inspecting, assembling, testing, and packaging, all of which can be embraced by automation in one continuous flow. Ways that automation principles can be applied to raise productivity, upgrade the skills of employees, improve products, expand capacity, and lower operating costs, are shown.

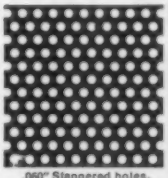
"This Is Automation" traces the subject history by beginning with those materials which were best adapted to a "flow" system, such as chemical and food, and continues to the so-called non-flowable products like cylinder blocks, condensers and refrigerator doors. According to G. E.'s new documentary film, manufacturing operations usually are in one of the following factory areas: manual, mechanization, and automation. The average of all operations performed in industry today would probably fall in the lower part of the mechanization area, it was estimated.

"This Is Automation" is part of

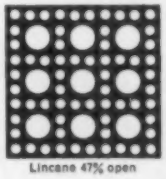
(Continued on page 405)

Perforated Materials for *Every* Application

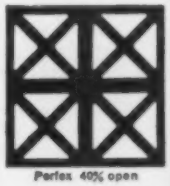
Contact H & K for any perforated materials your product may require.


.060" Staggered holes.
126 holes per sq. in.
3/32" centers. 36% open.

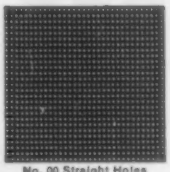
We will be glad to work with you on your perforating problems.


Lincane 47% open

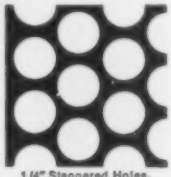
Perforating all metals, Masonite, plywood, paper, cloth and plastic.


Perfex 40% open

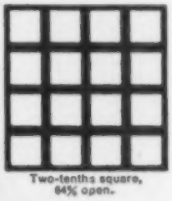
Fill-in and mail coupon to office and warehouse nearest you.


No. 00 Straight Holes
952 holes per sq. in.
.020" diam. 30% open.

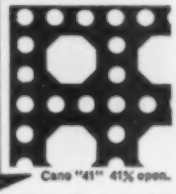
We have tools for perforating thousands of different patterns.


1/4" Staggered Holes.
5/16" centers.
.188" diam. 58% open.

See our catalog in Sweet's Product Design File.


Two-tenths square,
64% open.

Round holes, square holes, slots, ornamental patterns, oblong holes, oval holes.


Cano "41" 41% open.

1948
Harrington & King
PERFORATING CO.

Chicago Office and Warehouse
5617 Fillmore Street
Chicago 44, Ill.

New York Office and Warehouse
114 Liberty Street
New York 6, N. Y.

Please send me—

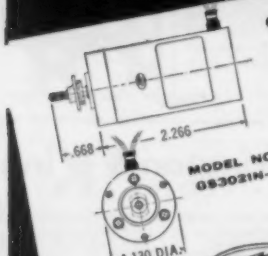
- ☐ GENERAL CATALOG NO. 62
- ☐ STOCK LIST of Perforated Steel Sheets
- ☐ SAMPLES of Perforated Plastics and Paper
- ☐ PRICE INFORMATION (NOTE: Send specifications of perforated materials wanted. If necessary send drawings or sketches.)

NAME_____
TITLE_____
COMPANY_____
STREET_____
CITY_____ ZONE_____ STATE_____

power
in a pillbox

EAD's
new miniaturized
1⅛ inch
servo-gear motor

For instant response and maximum torque in a miniature package it's EAD's tiny servo-gear motor, precision-designed for applications where size and weight are at a premium. Modifications available in hysteresis-synchronous and induction designs . . . Tell us your requirement.
Write for our new catalog.



CHARACTERISTICS	
Input Voltage	115
Phase	2
Frequency	400 cycles
No Load Speed	180 rpm
Full Load Speed	135 rpm
Rotor Inertia	1.25 gm. cm²
Stall Torque	7 oz. in.
Rated Torque	3 oz. in.
Size	1 1/8" dia. 2 17/64" long
Gear Reduction	28.4
Weight	4 1/2 oz.
Duty	Continuous

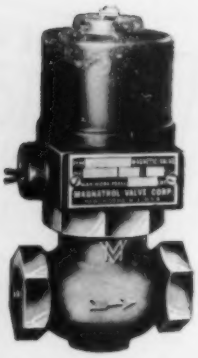
EAD

EASTERN AIR DEVICES, INC.
SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD

INDUCTION MOTORS · TACHOMETER GENERATORS · CENTRIFUGAL BLOWERS · FANS · ALTERNATORS · GEAR MOTORS

381 CENTRAL AVE., DOVER, NEW HAMPSHIRE

Eliminate
Costly
Flow Failures



Magnatrol
SOLENOID VALVES

Quick Operating *Non Sticking* *Tight Seating*

These three design advantages are your assurance against costly flow failures. Attain dependable, accurate, automatic or remote control of liquids or gases with **Magnatrol Valves.** Installed quickly and easily in connection with . . . flow-meters, thermostats, float and time switches. **Every Magnatrol Valve** is delivered to you—factory **tested**—guaranteed free from defects in material and workmanship.

Available in normally closed or normally open models. Pressure ranges from zero up to 300 PSI. Voltages to 575.

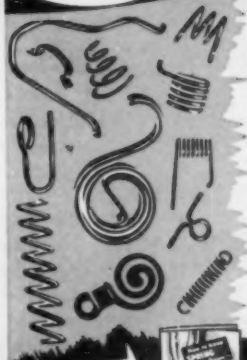
Catalog containing complete specifications mailed upon request.

Magnatrol VALVE Corp.
Dept. B - 67 5th Ave.
Hawthorne, N. J.

FOR *Quality Performance* from
WIRE FORMS
SPRINGS
METAL STAMPINGS

Rely on
DUDEK & BOCK

You get precision WIRE FORMS, Springs and Stampings that are easily assembled . . . that withstand stresses . . . perform under the most *trying* conditions. Rely on our free designing service. Our EXPERT ENGINEERS will produce design that meet your *exact* needs—and save you MONEY!



Valuable FREE Brochure

SPEEDY DELIVERY
WRITE—WIRE or PHONE
for Estimates and Delivery Dates

DUDEK & BOCK
SPRING MFG. CO.
4014 W. Grand, Chicago 51, Ill.

Phone:
DICKENS 2-1020

a More Power to America kit which includes a 36-page bulletin entitled "Automation." The entire kit is available on a loan or cost basis through the Apparatus Sales Division, Section 6-210, General Electric Co., Schenectady 5, N. Y.

Stainless Tubing Test Equipment

A new electrically energized instrument for the non-destructive testing of austenitic stainless steel tubing has been added to the production facilities of The Carpenter Steel Company's Alloy Tube Division, Union, N. J.

The new equipment, first of its kind installed in a tube mill, is said to give closer and more critical quality control than ever before possible. Its adaptation follows nearly two years of joint research and development by Carpenter and the Magnetic Analysis Corp., Long Island City, N. Y.

The unit inspects the inside and outside diameter surfaces of tubing along the length and periphery, and also tests the complete wall thickness or sub-surface of material with walls up to 0.070 in. Under certain conditions it will inspect the entire internal structure of even heavier wall tubing. No other commercial test method, Carpenter reports, is capable of detecting defects such as those found by this new device at production speeds.

Inspection by this method surpasses test standards specified by the American Society of Testing Materials. Current industry procedure involves random destructive testing only on certain sections of the tube.

In testing tubing by the lot, the machine detects any variation in chemistry, wall thickness, outside diameter and inside diameter. If, for example, the unit is set up to inspect Type 304 tubing, it will automatically reject Type 316 or any other type submitted for inspection, even though they are identical in size, gauge and overall appearance. This gives 100 per cent verification of the steel tubing chemistry.

The equipment, with its ability to pick up variations in wall thickness and diameters, gives greater assurance that all tubing inspected by this

(Continued on page 407)

GOT A PUMPING PROBLEM?

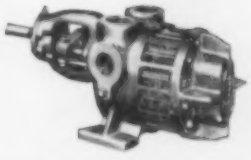
PERHAPS THE ANSWER YOU'RE LOOKING FOR IS A ROPER ROTARY PUMP

ROPER PUMP-MOTORS

These units offer low-speed and high-torque, and their versatility finds them well-suited to heavy-duty service within their operating range. In general, recommended speed is 200 to 800 R.P.M. with pressures to 800 P.S.I. In this range, they require from 7 to 40 G.P.M. flow and will develop up to 11.5 H.P. output at maximum speed and pressure.

ROPER SERIES F PUMPS

Among the dependable Ropers is the Series F Pump — pressures to 300 P.S.I., sizes 1 to 300 G.P.M. It features four-port design with 8 optional piping arrangements . . . supplied in standard fitted models. With packed box or mechanical seal; with or without relief valve.

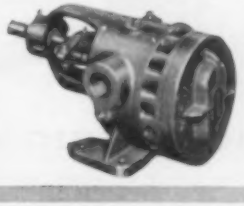


ROPER SERIES K PUMPS

Operate your hydraulic circuit with the correct size Roper for the particular job. In many cases the Series K will do, for it is rated from pressures to 150 P.S.I., capacities ¾ to 50 G.P.M. This model is compact, sturdy . . . is self-lubricated by liquid pumped. Comes with packed box or mechanical seal . . . with or without relief valve.

ROPER SERIES H PUMPS

Lower maintenance costs with a Roper. For instance, a pump like the Series H with pressures to 1000 P.S.I., sizes 10 to 75 G.P.M. is ideally suited for hydraulic mechanisms and for other applications requiring high pressures. Spur gears run in axial hydraulic balance . . . roller bearings and bronze wear plates reduce friction. Available with packed box or mechanical seal.



ROPER SERIES 3600 PUMPS

You'll profit more with dependable Roper Series 3600 Pumps on the job . . . they are speedy, quiet, and plenty rugged. Service-proved features such as self-lubrication, adjustable relief valve, hardened gears, and mechanical seal contribute to Roper dependability. Sizes range from 40 to 300 G.P.M.; pressures to 60 P.S.I.

GEO. D. ROPER CORP. 371 BLACKHAWK PARK AVE., ROCKFORD, ILL.

SEND NOW FOR DESCRIPTIVE BULLETINS

ROPER Rotary Pumps

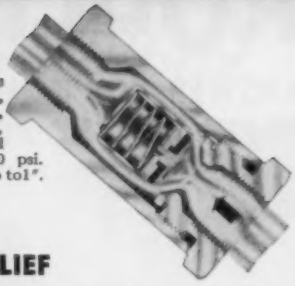
REPUBLIC

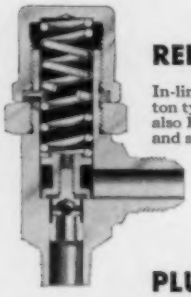
VALVES

INDUSTRIAL • CHEMICAL • AIRCRAFT

CHECK

Quality Check Valves of several types—ball, poppet, Hy-pressure, Free-flow—all metals, various portings, and pressures up to 3000 psi. Pipe and tube sizes up to 1".



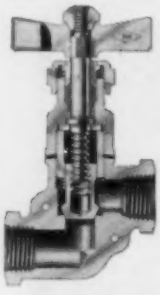


RELIEF

In-line and guided piston type Relief Valves, also Pilot Operated, with quick unloading and silent operation. Metal or rubber seal. ⅛" to ¾" pipe or tube port connections. Various metals.

PLUG

Precision-made Plug Valves for wide general use in brass, aluminum alloy, or stainless steel, ¼" to 1", +32° to 160°F. With Teflon plug, −65° to 250°F, without lubrication. Aluminum alloy or stainless steel.



GLOBE AND NEEDLE

Super duty shut-off valves, angle and offset, for up to 3000 service, ⅛" to 1". Also high pressure Needle Valves for 10,000 psi. working pressure—proofed at 25,000 psi. One piece, stainless steel, ⅛" to ½", Teflon packing.

LO-TORQ SELECTOR

Directional flow control for service up to 6000 psi. Balancing principle uses line pressure to make turning easy with short handle. 2, 3, 4-way, with various drillings. Side, bottom, and sub-plate porting. Panel mounting.

Ask for new catalog, No. 654, showing entire line.

Distributors in principal cities coast to coast.

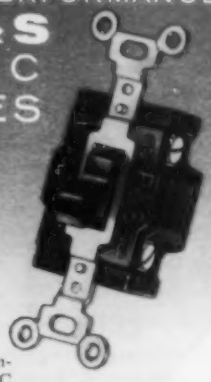
RM REPUBLIC MANUFACTURING CO.

15655 BROOKPARK ROAD • CLEVELAND 11, OHIO

FOR SUPER PERFORMANCE

GET P&S SUPER AC SWITCHES

For Extra Long Life
at Full Rated Load
Maximum Service
Quiet Operation



Finest materials and rugged construction make P&S Super AC Switches ideal for heavy duty usage. They can be easily installed in any position and are adaptable for back and side wiring. Underwriters' Laboratories, Inc., approved to full current rating on fluorescent (inductive) and incandescent lighting loads and on motors to 80% of switch rating.

P&S Super AC Switches are totally enclosed; have large silver alloy contacts that prevent overheating; single pole, double pole, 3-way and 4-way . . . 15 and 20 Amps., 120V and 277V AC, and many other features.

Write for complete information to Dept. PE-1.

P&S PASS & SEYMOUR, INC.

SYRACUSE 9, NEW YORK

71 Murray St., New York 7, N.Y. 1229 W. Washington Blvd., Chicago 7, Ill.
In Canada: Renfrew Elec. & Refrig. Co., Ltd., Renfrew, Ontario

A copy of this quick-reading, 8-page booklet is yours for the asking. It contains many facts on the benefits derived from your business paper and tips on how to read more profitably. Write for the "WHY and HOW booklet."

McGraw-Hill Publishing Company, Room 2710, 330 West 42nd St., New York 36, N.Y.

method has a consistent wall thickness exactly as specified on an order.

At the present time, the unit tests full finished, non-magnetic types of stainless steel including Types 304, 304L, 316, 316L, 321, 309, 310, 330, 347, 317, 317L, Carpenter No. 20-Cb and titanium. All material is inspected at production speeds.

As now set up, the equipment can inspect tubing with outside diameters ranging from ¼ to 3¼ in. Research is continuing to expand the size range and the extent of wall penetration in thicker tubing. Carpenter said it hopes to test all of its tubing and pipe non-destructively in the very near future.

This new quality control measure detects such critical flaws as carburization on the I.D. of a tube, weepers, mechanical defects caused by abusive handling, notches, I.D. gouges and imperfections in the parent metal.

Non-magnetic stainless grades having a permeability of 1.05 can also be easily inspected. The equipment functions at a high degree of efficiency so long as the magnetic permeability does not vary between the values of 1 and approximately 1.6 within a space of 2 in. to 4 in. along the length of a tube.

Sensitivity control makes possible adjusting the instrument to indicate defects of a pre-determined magnitude. Duplicate dial settings can be used to speed and simplify testing of repeat orders. Audio-visual signals warn the operator the very instant a defect passes through the testing coil. Test results are continuously visible on an oscilloscope as a tube passes through the detector device.

New Metals Pilot Plant

A metals pilot plant designed to bridge the gap between laboratory and commercial production of new alloys and processes has been opened by the Westinghouse Electric Corporation at Blairsvile, Pa. The six million dollars facility combines under one roof virtually all types of metal processing equipment.

The 173,000 square foot plant is the final link in Westinghouse's metallurgical development facilities. The plant is designed to process both wrought and cast alloys with equip-

(Continued on page 409)

Get TEFLON® that behaves as it should

Did you know that Teflon comes in various "grades"? Grade is governed by processing method and by purity. When you get the right grade for the job you will benefit by consistent performance from Teflon.

Premium grade is derived from virgin Teflon. That's what you get with *"electrical grade"* Fluoroflex-T. Conformance to important properties is *certified.** Its non porosity and optimum tensile strength assure reliability in even the most exacting service.

Economy is achieved without impairing chemical inertness in *"mechanical grade"* Fluoroflex-T. Some physical features of this reprocessed Teflon are even improved, since it offers better resistance to elongation with better dimensional stability the result.

In addition, *uniformity* of both grades is assured by a quality control system approved by the USAF under MIL-Q-5923, and by relieving of internal stresses in Fluoroflex-T rods, sheets, tubes and parts.

Send for more data – and for quotations on your needs.

*Copies of test reports on file available on request.

®Fluoroflex is a Resistoflex registered trade mark for products from fluorocarbon resins. Teflon is the DuPont registered trade mark for its tetrafluoroethylene resin.

RESISTOFLEX
CORPORATION • Belleville 9, New Jersey

Portrait by Fabian Bachrach

Bell Aircraft has 13,000 payroll savers

"From every point of view, the purchase of U. S. Savings Bonds contributes to the soundness of our economy and to the individual security of our citizens. I am proud that at Bell Aircraft our employees are helping to strengthen the national economy and their own future security through the Payroll Savings Plan.

"In a recent campaign Bell employees achieved a record of nearly 99% participation in the Payroll Savings Plan, bringing to 13,000 the total number of our employees who are saving systematically through the regular purchase of Savings Bonds."

LARRY BELL, *President Bell Aircraft Corporation*

If your company does not have the Payroll Savings Plan, or if you have the Plan and employee participation is less than 50%—get in touch with Savings Bond Division, U. S. Treasury Department, Washington, D. C. Your State Director, U. S. Treasury Department, will be glad to help you install a plan or show you how easy it is to build employee participation in your present plan.

The United States Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

Product Engineering

ment flexible and large enough to permit actual manufacturing conditions. In this way, moderate production output will uncover problems that can only be found under actual manufacturing conditions.

The plant equipment is flexible. For example, the induction vacuum melting installation can accommodate heats in the range from 300 to 2000 lb. This installation can be used for vacuum casting of large ingots as well as low temperature vacuum annealing of titanium.

Equipment in the Blairsville plant permits the manufacture of specialty metal products at competitive costs, allowing reasonable loading of tools that normally cannot be loaded fully on development work. This operating policy not only lowers the cost of development work but also provides trained operating crews for all the equipment, according to Mr. Warren Trigg, Plant Manager.

The plant is situated on a 540-acre tract 40 miles east of Pittsburgh. Included in the plant, believed to be the largest pilot plant of its type in the country, is an 18,000 lb besides three smaller forge hammers; a 1000-ton steam-hydraulic forge press; seven forge furnaces; three induction melting furnaces which vary in size up to 5000 lb; a cold hearth furnace; a 1000-hp reversing, hot-rolling mill; a 500-hp reversing, cold-rolling mill; bell type and roller rail box-type electric furnaces; a shot pouring facility; shell mold and lost wax investment casting facilities; and arc furnaces.

On the list of Blairsville projects is further development of the alloys Discaloy, Refractaloy, K-42-B, Hipernik, Hiperco, Hipersil, and Kovar. The first three are high temperature alloys for application in gas and steam turbines. Here, rotors and blades must withstand stresses at extremely high temperatures and also resist corrosion and remain ductile. Hipernik, Hiperco, and Hipersil are magnetic alloys used in saturable reactors, magnetic amplifiers and choke coils. Kovar is an expansion alloy used where an airtight seal between glass and metal is required.

The plant was designed by the Westinghouse East Pittsburgh Works Engineering Department. Contractors were: Navarro Corporation, general; Patterson-Emerson-Comstock, Inc.,

(Continued on page 410)

NEW! BENDIX-FRIEZ DESIGNER'S THERMISTOR KIT

12 Individually Packaged Rod-Type Elements, 25 to 1,000,000 ohms range

Here's a real time-saver for the busy designer from Bendix-Friez.* This new Rod-Type Thermistor Kit contains twelve standard elements for applications in sensing, controlling and indicating devices. Handy compartment case keeps thermistors separate and ready for quick use. Indexed boxes save time, assist in specifying and ordering.

These twelve thermistor elements range in resistance from 25 ohms to 1,000,000 ohms. Kit comes complete with specifications, covering dimensions, voltage-current characteristics and temperature resistance relationships. An up-to-date list of references are cataloged for your convenience according to thermistor applications. Mass quantities available for any or all of these 12 different thermistors.

*Reg. U. S. Pat. Off.

Order your kit now. Or write for complete information.

Bendix-Friez

FRIEZ INSTRUMENT DIVISION
BENDIX AVIATION CORPORATION
BALTIMORE 4, MD.

Export Sales and Service:
Bendix International Division
205 E. 42nd St., N. Y. 17, N. Y., U. S. A.

Bendix-Friez
1404 Taylor Avenue
Baltimore 4, Maryland

Gentlemen:
Enclosed is my check for $.....(add .50 per kit for packing and shipping charges). Please send.....No. 100 Designer's Thermistor Kits. C.O.D.'s accepted.

Name.....

Street.....

City.....State.....

structures

STRESS ENGINEERS
STRUCTURES ENGINEERS
WEIGHT ENGINEERS
LOADS ENGINEERS
DYNAMICS ENGINEERS
FLUTTER ENGINEERS
COMPUTER SPECIALISTS
MECHANICAL ENGINEERS
CIVIL ENGINEERS

Expansion within Northrop Aircraft's Structures Department is creating an urgent demand for qualified personnel in all phases of guided missile, piloted aircraft, and equipment development. Included among the most critical job openings are positions for:

Stress Department—Mechanical or Civil Engineers to design missile ground handling equipment. An opportunity for men without aircraft experience to take advantage of the aircraft pay scale.

Structures Research—Creative engineers for three vital phases of Structural Research and Development: Thermo-Structural Analysis, High Speed Computing Technique Development and Structural Materials Research.

Weight Engineering—Junior Weight Engineers for diversified phases of missile and aircraft projects. Excellent opportunities for advancement in a relatively small department.

Dynamics—Experienced flutter engineers required for work on a variety of dynamics problems including flutter models, analytical work involving electronic computers, and methods development.

Loads—Exciting and diversified assignments in the fields of both piloted and pilotless aircraft are now available in Structural Loads Group for engineers of all experience levels.

Stress Department—Experienced Structural Engineers for positions on Long Range Interceptor Project and on advanced missile designs.

A wide diversification of assignments within each field of specialization awaits the men capable of filling the above assignments. Responsibilities will include work on many phases of missile and aircraft design, guidance systems and boundary layer research.

If you qualify for any of these challenging opportunities, we invite you to contact Manager of Engineering Industrial Relations, Northrop Aircraft, Inc., Hawthorne, California, or call ORegon 8-9111, Extension 1893.

NORTHROP AIRCRAFT, INC.

PIONEERS IN ALL WEATHER AND PILOTLESS FLIGHT

8-A-49-8

electrical; and Limbach and Company, mechanical. All are from Pittsburgh. The F. H. McGraw and Company of New York did the equipment erection and installation work including piping and electrical installations.

Electronic Equipment Exhibited Aboard Boat

An offshore 52-foot boat has been equipped by Cornell-Dubilier Corp., to demonstrate a large range of filtering and converting equipment developed specifically by the company for pleasure craft use.

A series of Portable Powercon vibrator units convert power from a 32-volt battery system to usable a-c. A television set operates with a dual vibrator which gives almost continuous service through an automatic changeover from service to spare vibrator in less than two seconds. These sine-wave units have built-in voltage regulating features, low interference level, and long vibrator life, according to the company. The per cent change in output voltage is said to be held to less than one-third of the per cent change in input. A third converter unit aboard the electronically equipped boat makes possible use of a tape recorder, electric shaver, dictating machine and an electric recording log. The filters installed are attached to the twin GM diesel engines and the various shipboard pumps and motors.

Raytheon Opens New Electronic Facility

Raytheon Mfg. Co. has opened the largest industrial electronics laboratory in New England at Wayland, Mass. The electronics firm headquarters are in nearby Waltham. The two-story brick structure situated on a 73-acre site is for engineering and development of advanced electronics equipment for both government and commercial applications. Total floor space is approximately 225,000 square feet, including more than five acres of laboratories, offices, drafting rooms, and machine shops. About 1200 employees are housed in the new building. Engineering activities were formerly carried out in seven separate localities.

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

UNDISPLAYED RATE

$1.80 a line, minimum 3 lines.

To figure advance payment count 5 average words as a line.

Box Numbers—Care of publication count as one line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Equipment Wanted or For Sale Advertisements acceptable only in Displayed Style.

DISPLAYED RATE

Individual Spaces with border rules for prominent display of advertisements.

The advertising rate is $16.85 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on one column, 3 columns—30 inches—to a page.

NATIONAL COVERAGE

EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Positions Vacant	Civil Service Opportunities	Employment Agencies
Positions Wanted	Selling Opportunities Wanted	Employment Services
Part Time Work	Selling Opportunities Offered	Labor Bureaus

RATES

DISPLAYED

The advertising rate is $23.20 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

UNDISPLAYED

$1.80 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box Numbers—counts as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

Send NEW ADS to PRODUCT ENGINEERING, 330 W. 42nd St., N. Y. 36, N. Y., for August issue closing July 21st.

RELAYS

MINIATURE AIRCRAFT • TELEPHONE TYPE • HERMETICALLY SEALED • SENSITROLS • STEPPING SWITCHES • GUARDIAN • KURMAN • ALLIED • SIGMA • LEACH *and many others.*

LARGEST STOCK OF RELAYS IN THE WORLD

PRODUCTION QUANTITIES IN STOCK

Send for our latest bulletin P

324 CANAL ST., N.Y.C. 13, N.Y. WAlker 5-9642

Universal general corp.

THREADED Rods

10 to 12 ft. lengths
ALL METALS
Also Screw Machine Products to Order

EASTERN
Machine Screw Corp.
12-32 Barclay St.
New Haven, Conn.
Makers of H & G Die Heads

ENGINEERS

Electronic *Mechanical*

There's room to... GROW AT MELPAR

Currently we seek men with experience in one or more of the following:

- Network Theory
- Systems Evaluations
- Microwave Technique
- UHF, VHF, or SHF Receivers
- Analog Computers
- Magnetic Tape Handling
- Digital Computers
- Radar and Countermeasures
- Packaging Electronic Equipment
- Pulse Circuitry
- Microwave Filters
- Flight Simulators
- Servomechanisms
- Subminiaturization
- Electro-Mechanical Design
- Small Mechanisms
- Quality Control and Test Engineers

More and more these days you hear top engineers talk about the many growth opportunities at Melpar. With an increasing number of significant electronic projects, an enlarged staff and facilities, Melpar provides many opportunities for professional growth and advancement. Our new laboratory is an engineer's dream come true; a building conceived by and constructed for the ENGINEER – 265,000 sq. ft. of complete engineering facilities.

We are located in Fairfax County of northern Virginia where housing is reasonable and plentiful—whether you desire a private home or an apartment. Although we are in a truly suburban atmosphere, we are only 10 miles from the nation's capital with all its recreational and social advantages. Here you and your family can grow in an environment to match your professional growth.

Send resume to Technical Personnel Representative,

melpar, inc.

A subsidiary of the Westinghouse Air Brake Co

3000 Arlington Blvd., Dept. PE-25 Falls Church, Va.

11 Galen Street, Watertown, Mass. • 99 First St., Cambridge, Mass.

PROFESSIONAL SERVICES

DESIGN ASSOCIATES

Tool Designing Available

Jigs, Fixtures, Progressive and Compound Dies
Layout and Detailing Service

2439 N. Charles St. Baltimore 18, Md.

GEORGE H. KENDALL

Consulting Mechanical Engineers

Methods Studies: Process or Product
Redesign Existing Products for Greater Profit.
Trouble Shooting Production, Design, Cost Problems.
Specialist Automatic Machinery, Process, Controls.
New Developments, Patent Studies, Investigations.
New Products & Process Engineering Studies
P. O. Box 3 (Est. 1923) Tel. Darien 5-1844
Noroton Heights 2 Offices Darien, Connecticut

WILLARD F. MASON

Consulting Electrical Engineer

Precision Electromechanical Designs
Specialist Slip Ring Assemblies—All Applications
Engineering Administration, Cost Systems
Product Development Programs
Manufacturing Facilities

180 Post Road, Darien, Conn. Oliver 5-9680

MECHANICAL ENGINEERS and DESIGNERS

with several years experience in heavy machine design, or allied fields,

INVESTIGATE

this oportunity to join an old established company in a new division where you will find challenging work and the chance for rapid advancement. Location near Harrisburg, Pa. Excellent salaries. We pay interview and relocation expenses.

Replies confidential. Write or wire—

Mr. K. E. Eyler

NATIONAL-U. S. RADIATOR CORP.

BOX 231, MIDDLETOWN, PA.

MECHANICAL ENGINEERS

LOOKING FOR THE RIGHT CHANGE!

- **Many men are — and the *right* job is often mighty hard to find.**
- **But we've got some interesting openings now at Admiral that might represent the right change for you.**

DUTIES OF THE JOBS:

Solve electro-mechanical design and layout problems at the developmental level. Work from rough sketches or general instructions to fully utilize your ingenuity and creative abilities.

SCOPE OF THE WORK:

To bring into design form the requirements of a new or modified instrument, device, or control system related to TV and radio receivers as well as government military equipment. Plus co-ordinate all mechanical aspects of the project.

ATMOSPHERE:

A company that understands engineering — with a well planned long range program of design and development. Plus a complete program of employee benefits.

YOUR POTENTIAL:

Continued company growth offers many excellent opportunities for advancement.

REQUIREMENTS:

Graduate mechanical engineers or men of equivalent backgrounds having industrial experience.

For details write Mr. W. A. Wecker, Personnel Division. We will be happy to send you more information on career opportunities and other advantages.

Admiral Corporation
3800 W. Cortland St.
Chicago 47, Illinois

DESIGN ENGINEERS

Company expansion provides openings in design of precision electro-mechanical instruments and sub assemblies used in the aircraft and guided missile fields. M.E. or E.E. Degree necessary.

Live in RIVERSIDE, a southern California community centrally located between beach, mountain and desert resort areas. Only one hours drive to Los Angeles.

A growing organization offering security and excellent opportunity for advancement. Also profit sharing, paid vacations, sick leave, paid holidays, life insurance, medical and group hospitalization program. 40 hr. week.

Send resume, photo and salary requirements to:

BOURNS LABORATORIES, INC.
6135 Magnolia Ave.
Riverside, California

EXPERIENCED DESIGNERS - LAYOUT MEN

To Work At General Motors New Technical Center

For Experimental Automotive Work in Transmissions, Engines & Chassis.

The Engineering Staff is located in the suburbs of Detroit on an 820 acre site devoted to research and development work. Splendid opportunity for men looking toward the future. Ideal working conditions in well lighted, air conditioned office building. Fine recreational program with golf course adjacent to site. Opportunity to become a share holder in GM through a generous Stock Purchase Program. Also excellent health insurance, life insurance, and retirement plans.

State full particulars: Age, Experience, Salary Expected, Etc. *Send resume to:*

Personnel Dept.
Engineering Staff
General Motors Corporation
GM Technical Center
Detroit 2, Michigan

GROUP SUPERVISOR
LOS ANGELES

Direct activities of hard-hitting group design and development engineers in electro-mechanical and electronics fields. This aggressive company will start you around $12,000 and pay agency fee, relocation and interview expense.

MONARCH PERSONNEL
28 E. Jackson Blvd. Chicago 4, Ill.

Executives and Engineers deserving higher salary

now can *completely, confidentially* make arrangements for better positions through our unique Job Improvement Service. We have close contact with leading manufacturing and research firms in all sections of the country.

Here's what you do. Send us your name, title, company and *home address.* We will forward to your home brief forms which you fill out and return. We compare your experience and desires with our file of specific job openings. You make the decision. No obligation to you, no cost whatsoever. Our clients pay us to find you. Find out what you're really worth—today. Write, phone or wire.

DECISION INC.

Management and
Recruitment Consultants
Oliver P. Bardes, President
451 First National Bank Building
Cincinnati 2, Ohio

ENGINEERS

The APPLIED PHYSICS LABORATORY of THE JOHNS HOPKINS UNIVERSITY offers an exceptional opportunity for professional advancement in a well-established Laboratory with a reputation for the encouragement of individual responsibility and self-direction.

Our program of

GUIDED MISSILE RESEARCH and DEVELOPMENT

provides such an opportunity for men qualified to design:

GUIDANCE, HOMING, AND CONTROL CIRCUITS
ANTENNAS
MICROWAVE COMPONENTS
COMPUTERS
THE EXTERNAL AERODYNAMICS OF MISSILES
RAMJETS
MISSILE STRUCTURES
LAUNCHERS
DATA-RECORDING AND PROCESSING EQUIPMENT

Please send your resume to Professional Staff Appointments

APPLIED PHYSICS LABORATORY
THE JOHNS HOPKINS UNIVERSITY
8641 Georgia Avenue
Silver Spring, Maryland

Dear wife and kids:

Got here o.k. today. Couldn't wait to tell you what I think of Farnsworth and Fort Wayne. It's more than a place to work .. it's a way of life! Most of the folks here own their own homes. There are no row houses and that cottage in the country is <u>real</u> and only 10 minutes from everywhere.

Schools? There are 50 of them (full time .. no half day shifts!) 5 beautiful High schools <u>and</u> I can take grad work at Purdue here at Farnsworth's expense!

This is also a town of churches ... 132 in a town of 135,000 that boasts one of the lowest juvenile delinquency rates in the country.

There's also a full size, full season symphony orchestra ... World championship basketball and hockey in a new 3 million dollar coliseum that's out of this world. (Are you listening, Jackie?)

Tell Joe and his wife to start packing because there's plenty of room here for more engineers like him in R and D and systems engineering in missiles, radar, antennas, microwaves, test equipment, countermeasures, transistor applications and other phases. Tell him to write the Technical Employment Manager, Farnsworth Electronics Co. (a division of IT&T) at Fort Wayne, Ind. He'll be glad he did.

I can't wait until you and the kids get here ... I <u>know</u> you'll love it. And, like they say at Farnsworth, "Very, very few ever leave it."

Love Jack

PROJECT ENGINEERS

Electro-Mechanical

Opportunities are available in controls engineering department of leading aircraft accessories manufacturer. These are responsible positions requiring men with 7-10 years experience in electro-mechanical engineering. The work is related to precision control of relatively large high speed turbine driven devices. Previous supervisory experience necessary. Openings exist in the following areas:

Design and Development of Control Systems
Development and Test of Control Components
Product Engineering of Control Components

These are permanent positions with excellent opportunities for advancement under excellent working conditons.

Submit complete resume, including past earnings and availability for interviews in first letter to:

TECHNICAL EMPLOYMENT
THOMPSON PRODUCTS, INC.
23555 EUCLID AVENUE CLEVELAND 17, OHIO

WANTED

PRODUCTION SUPERVISOR

Exceptional opportunity for permanent position responsible DIRECTLY TO THE PRESIDENT for man under 40 with good education and experience in mass production especially of medium sized forgings, hardening and finishing, and to set up and operate production control and cost in modern progressing plant with friendly atmosphere. Apply in confidence with full information to:

Ernest Estwing
ESTWING MFG. CO.
Rockford, Ill.

WANTED

MANUFACTURER'S REPRESENTATIVES

To handle line of color anodized aluminum foil nameplates with adhesive backing. Protected territories open on an exclusive, commission basis. Wide acceptance by blue chip manufacturers.

RW-8691, Product Engineering
330 W. 42 St., New York 36, N. Y.

TO AN ENGINEER, 28-34, HEADED FOR TOP LEVEL PLANT MANAGEMENT:

Here is your chance to enter our management development program at a much higher than usual level.

We are a midwestern major appliance manufacturer. This opportunity is open to you now only because our growth has been so swift, profitable and sound that there hasn't been time to staff our organization completely from within. We follow the policy of appointing men of ability to top jobs as early in their careers as possible. A number of our key management personnel are in their early thirties.

You must have the mark of a man going places—in your college engineering studies, your personal and family interests, and your business career. As a person you must have drive, confidence and vision.

Your business experience has already carried you to a supervisory level and you value association with a well established company that is on the move.

Salary will be $10,000 to $12,000 plus a bonus of about 25%. Replies strictly confidential. Send brief but complete resume of personal, educational and business background.

P-8432, Product Engineering
520 No. Michigan Ave., Chicago 11, Ill.

PROJECT DESIGNERS

Mechanical Engineering graduates, age 30-45, with minimum of four years design experience in power tool field, to design new and special products for a standard line of tools.

Salary commensurate with capabilities.

Send resume with full particulars to:

H. C. GEBHART, *Chief Engineer*
Delta Manufacturing Company
Bellefontaine, Ohio

Your Inquiries to Advertisers Will Have Special Value . . .

—for you—the advertiser—and the publisher, if you mention this publication. Advertisers value highly this evidence of the publication you read. Satisfied advertisers enable the publishers to secure more advertisers and—more advertisers mean more information on more products or better service—more value—to YOU.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)
LOS ANGELES: 1111 Wilshire Blvd. (17)

POSITIONS VACANT

Consultant in design and tooling for commercial and domestic electric cooking and heating appliances. Services available on per diem or fee basis. P-8029, Product Engineering.

Development Supervisor: Excellent opportunity for an experienced mechanical engineer interested in supervisory position in engineering department which is rapidly undertaking expanding functions. Good potential for further development and advancement necessary. Must be capable of giving direction and guidance to experienced engineers engaged in a diversity of projects on small mechanical devices and movements. Our company is located in the Baltimore Metropolitan area, and is generally considered to be the industrial leader of its field. Send complete resume with detailed work history. All replies confidential. P-8461, Product Engineering.

Belt Engineer—Flat and V-belts. Experienced in latest compounding and manufacturing methods. For approximately three months work in foreign country. Salary and expense basis. Retired engineer acceptable if experience is recent. Write with full particulars of qualifications, salary and availability. P-8463, Product Engineering.

FOR RATES OR INFORMATION

About Classified Advertising

Contact

The McGraw-Hill Office Nearest you

ATLANTA, 3
1321 Rhodes-Haverty Bldg.
WAlnut 5778
W. LANIER

BOSTON, 16
350 Park Square
HUbbard 2-7160
P. McPHERSON

CHICAGO, 11
520 N. Michigan Ave.
MOhawk 4-5800
H. BOZARTH
W. HIGGINS

CLEVELAND, 15
1510 Hanna Bldg.
SUperior 1-7000
C. J. LOUGHLIN

DALLAS, 2
Adolphus Tower
Main & Akard Sts.
J. CASH

DETROIT, 26
856 Penobscot Bldg.
WOodward 2-1793
L. SEEGAR

LOS ANGELES, 17
1111 Wilshire Blvd.
MAdison 6-4323
H. L. KEELER

NEW YORK, 36
330 West 42 St.
LOngacre 4-3000
R. LAWLESS
W. SULLIVAN
D. COSTER

PHILADELPHIA, 3
17th & Sansom St.
RIttenhouse 6-0670
E. MINGLE
J. WILLIS

PITTSBURGH, 22
919 Oliver Bldg.
ATlantic 1-4707
C. J. LOUGHLIN

ST. LOUIS, 8
3615 Olive St.
JEfferson 5-4867
H. BOZARTH

SAN FRANCISCO, 4
68 Post St.
DOuglas 2-4600
R. L. ALCORN

Index of

PRODUCTS ADVERTISED

In This Issue

A

Accelerometers 271

Accumulators 90-91

Actuators
Electrical 243, 389
Mechanical 338-339

Adhesives 103

Aluminum Alloys .....24-25, 76-77...83, 332, 333, 343, 384, 398

Aluminum Coated Sheet and Strip (see Steel, Coated)

Amplifiers 370, 380

Assemblies
Electrical 229, 243
Hydraulic 305
Pneumatic 328-329
Structural 257

Axles 316

B

Balls 378

Bars
Metal 18-19, 51, 93, 253, 343, 375

Bearing Materials 36, 84

Bearings
Ball.....54, 61, 134, 227, 288, 374, 378
Jewel 393
Miniature 106, 134
Needle 54
Roller ..4th cover, 54, 61, 227, 235, 288
Self-Lubricating 376
Sleeve 84, 253, 375

Bellows 314, 337, 342

Belt Lacers 353

Belts 52, 118, 254, 286-287, 341

Bi-Metal 31, 354

Blowers 269, 363, 392

Bolts 225, 268, 275, 388
Books 403

Boosters 90-91, 303

Brake Motors .....3rd Cover

Brakes
Electric 48
Hydraulic 304
Mechanical 304

Brass 53

Brazing
Alloys 325

Bronze 36

Bushings 84, 253, 308

C

Cams 415

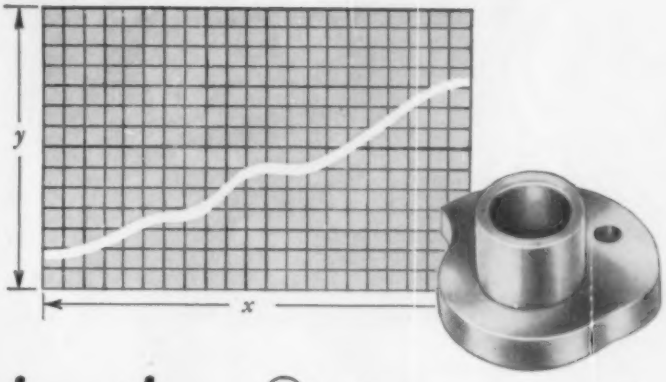
Carbon 62-63

Castings 306, 371

Castings, Precision Investment..60, 96, 319, 385, 422

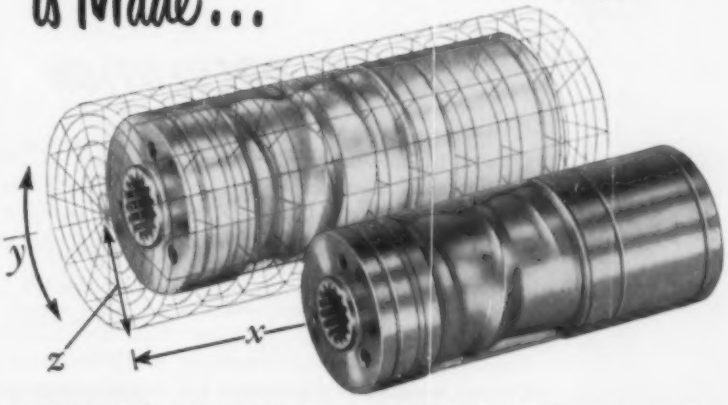
Continued on p. 416

Here's How a 2 Dimensional Cam is Made...



Here's How a 3 Dimensional Cam is Made...

$z = f(x,y)$



HERE'S HOW YOU CAN GET THE GRAPHIC STORY OF CAMS THAT "COULDN'T BE BUILT"—*BUT WERE DELIVERED BY PARKER!*

Send today for the new, fact-filled Parker folder—discover how Parker can engineer and build three dimensional cams with an infinite number of precisely machined stations to serve as the "brains" for a wide range of automatic operations.

THE PARKER STAMP WORKS, INC.
CAM DIVISION
FRANKLIN AVENUE • HARTFORD, CONNECTICUT

by Parker

VIBRATION-DAMPING

SHOCK-ABSORBING

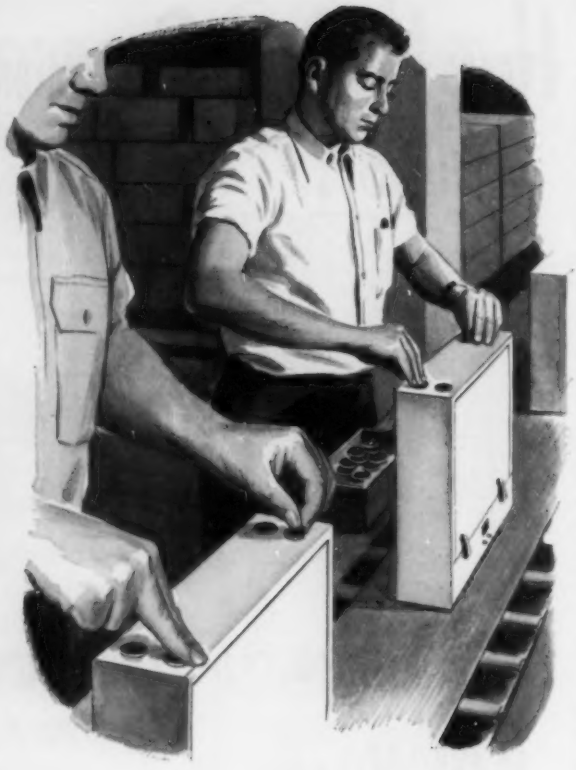
SKID-PROOFING

CUSHIONING

NOISE-KILLING

SCRATCH-PREVENTION

GLAZING STRIP



SCRATCH-PREVENTION

General Electric use small pads of Armstrong DK-153 Tape to make sure their light boxes won't scratch desk or table tops. This resilient, cork-and-rubber sponged-rubber material does a good job of absorbing shocks and preventing skids, too.

DK-153 is easy to apply—it's backed with a tacky adhesive that sticks to almost any clean, dry surface. You can get it in tapes, rolls, sheets, or die-cut shapes in many widths and thicknesses. For samples, write on your company letterhead to Armstrong Cork Company, Industrial Div., 7301 Irvin St., Lancaster, Pa.

Armstrong DK-153 TAPE

. . . used wherever performance counts

Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 415

Ceramics 374

Chains
Conveyor 13, 397
Roller 13, 262, 397
Silent 13, 397

Chemical Treatments 94, 280

Circuit Breakers 122-126

Clad Metals 240

Clamps 392

Clamps, Hose 340

Clips 132

Closures 95

Clutches
Mechanical 14, 290, 299, 373, 428

Coatings 8, 94, 103, 249, 280, 374, 386

Coils 56-57, 378

Cold Headed Parts 275

Computers 334, 370, 390

Connectors
Electrical 350
Hose 314
Tube 314

Contactors 17, 67-68

Contacts & Contact Materials 56-57

Controllers 107

Control Panels & Switchboards 67-68, 107, 393

Controls
Electrical 56-57, 67-68, 107, 122-126, 256, 370
Electronic 67-68, 107, 122-126, 370
Hydraulic 303, 305, 335
Mechanical 402
Pneumatic 26-27, 104, 335

Conveyor Belts 318

Copper & Copper Alloys 2

Cork Compositions 416

Counters 17, 389

Couplings (see Connectors, Electrical)

Couplings
Hydraulic 309, 400
Mechanical 48, 290, 309, 373

Cylinders
Hydraulic 90-91, 278, 283, 311, 333, 335, 367, 398

Pneumatic 90-91, 278, 283, 311, 333, 335, 367, 398

D

Decalcomanias 388

Deep Drawing 295

Dials 393

Die Castings 96, 267, 292

Dimmers 256

Drafting
Machines 35, 69
Supplies 35, 69, 323, 402

Index of

PRODUCTS ADVERTISED

In This Issue

•

Drives
Adjustable Speed 28-29
Hydraulic 309, 315, 345
Timing 118, 379
Variable Speed ..... 3rd Cover, 26-27 48, 92, 122-126, 286-287, 370

Dynamometers 48

E

Engineering Services (see also Production Services) 71, 109, 114, 127 233, 334, 393

Engines 111, 377, 386
Expanded Metals 274

Expansion Joints 314, 342

Extrusions
Metallic 2, 74, 76-77, 83, 272 313, 343, 350, 366

Non-Metallic 344

F

Fabricated Plastics, (See Plastics, Fabricated)

Fabricated Steel (see Plate, Fabricated, Sheet Fabricated, Structural Forms & Shapes, see Weldments)

Facings, Clutch 341

Fastening Methods 87, 132, 245

Fibre 356, 372

Fibre Glass 312

Filters
Air 328-329, 360, 395
Hydraulic 112, 360, 395

Flexible Couplings ...117, 290, 306, 326

Flexible Shafts 231

Floats 276

Forgings 246-247, 259, 261, 272, 343 355, 368

Friction Materials 341, 416

Furniture, Engineering Dept..... 402

G

Gages, Pressure or Vacuum..... 361

Gaskets 79, 98

Gear Motors (see also Motor Reducers) 229, 404

Gears 6, 11, 75, 81, 109, 244, 279 281, 322, 324, 338-339, 375, 390, 400

Governors 104

Graphite 62-63

H

Heating Units 122-126, 310, 359, 388
High Temperature Alloys..... 74
Hose & Tubing..... 289

Continued on p. 418

The most advanced developments in electronics are being made in the sphere of airborne radar and related ground control systems because of military emphasis.

Further applications of electromechanical techniques in these fields are creating new openings in the Systems Division of Hughes Research and Development Laboratories.

Engineers who have demonstrated ingenuity and inventive ability will find interest in areas of work that call for devising reliable, maintainable, manufacturable designs for precision equipment developed at Hughes Research and Development Laboratories.

The design of this equipment, manufactured at Hughes, involves mechanical, electromechanical, electronic, microwave and computing problems. Design also requires the use of such advanced techniques as subminiaturization, unitized "plug-in" construction, with emphasis on design for volume production. Knowledge of electronic components, materials, finishes and military specifications is useful.

SCIENTIFIC STAFF RELATIONS

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

DESIGNERS ...

if your advancement is blocked—read this!

No need to worry about a future if you are in one of our design groups. Here, there are plenty of avenues for achievement. Many, incidentally, are high-speed highways to responsibility and better income.

Today our J-57 turbojet is the world's most powerful production aircraft engine. It powers nine of today's fastest military aircraft. It will power the luxury airliners recently ordered by Pan American World Airways and United Airlines.

But our business is *not* static. We are constantly improving current engines—developing newer, more powerful engines.

Obviously, in a continuing program like this, designers are key men. They have virtually unlimited opportunities to build sound, well-rewarded careers.

If you want to get off a dead-end street, investigate! There's an excellent chance we have the present *and future* you want.

PRATT & WHITNEY AIRCRAFT
DIVISION OF UNITED AIRCRAFT CORPORATION
EAST HARTFORD 8, CONNECTICUT

MR. E. M. PETERSON
Dept. 7, Design Employment
Pratt & Whitney Aircraft
East Hartford 8, Connecticut

I would like to learn more about your openings for product and component designers. My experience has been in the following fields:

☐ Nuclear Design
☐ Compressors
☐ Turbines
☐ Structures
☐ Afterburners and Related Equipment
☐ Aerodynamics
☐ Hydraulics
☐ Gears
☐ Valves
☐ Heat Exchangers and Combustion Problems
☐ Bearings
☐ Piping
☐ Controls
☐ Test Equipment
☐ Test Rigs
☐ .....
☐ .....

Total years Mechanical Design experience .....

You can reach me at ..... (telephone number)

Most convenient hours for receiving calls are between ..... and .....

Name .....

Address .....

City ..... State .....

Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 417

I

Instruments Mechanical 386
Insulation 241, 312
Insulators 396

J

Jewels 393

L

Laminated Plastics (see Plastics, Laminated)
Locks 382
Lubricating Equipment 263, 328-329

M

Magnesium Alloys 324, 350
Marking Machines & Tools..... 350
Moldings
Glass (see Glass Parts)
Plastics (see Plastic Parts)
Powdered Metal (see Powdered Metal Parts)
Rubber (see Rubber Parts)
Motor Reducers (see also Gear Motors)
Motor Starters 56-57, 67-68
Motors, A-C
Fractional .....3rd Cover, 16, 28,-29 44, 122-126, 130, 270, 284, 293 301, 317, 384, 404
Integral..3rd Cover, 28-29, 44, 122-126 270, 293, 301, 384
Sub-Fractional 28-29, 130, 270 284, 357, 404
Motors, D-C
Fractional ...16, 44, 122-126, 130, 270 284, 301, 317, 404
Integral 44, 122-126, 270, 301
Sub-Fractional 130, 270, 284, 404
Motors, Hydraulic 315, 345, 369, 405

N

Name Plates 388, 393
Nickel Alloys 46, 86, 93
Nuts 43, 87, 120, 132, 225, 374 382, 388

O

Optical Parts 250
Overload Relays 56-57

Index of

PRODUCTS ADVERTISED

In This Issue

•

P

Packings 55, 237, 296, 419
Paper 88
Perforated Metals 403
Photographic Equipment
Film 323
Paper 323
Pillow Blocks 309
Pins 268
Pipe 22-23
Plastic Film 37
Plastic Parts 105, 282, 292, 298 330-331, 344, 351
Plastics.....33-34, 105, 307, 330-331, 349 351, 394, 399, 407
Plastics Fabricated 298
Plastics Laminated 356
Plated Metals 384
Plates 100, 403
Plugs 268
Porcelain 396
Powdered Metal Parts....80, 84, 89, 116 253, 375
Power Packs
Electrical & Electronic..... 370
Hydraulic 305
Production Machines & Processes 300, 375
Production Services (see also Engineering Services) 108, 109, 127 324, 347, 393
Pulleys 286-287
Pumps
Air 360, 382
Liquid 32, 72-73, 119, 269, 303 305, 315, 335, 345, 348, 360 362, 369, 396, 405, 427
Vacuum 360, 382

R

Radioactive Sources & Materials..... 393
Ratchets 375
Recorders 390
Rectifiers 352
Regulators
Hydraulic 305
Pneumatic 328-329
Relays 65, 67-68, 101-102, 104, 214 256, 365, 424
Reproduction Equipment 35, 69
Reproduction Supplies 35, 69, 323
Resins 15, 40, 351
Resistors 101-102, 256
Resolvers 334
Retaining Rings 42, 99, 392

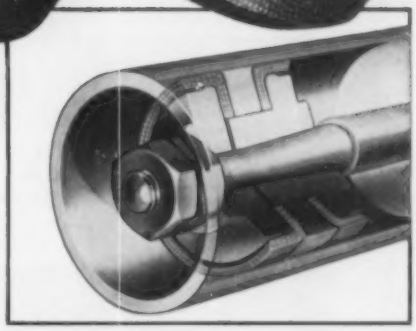
Continued on p. 420

PUMCUP ADVANTAGES

now yours for

• HYDRAULIC CONTROLS
• AIR CYLINDERS
• RECIPROCATING PUMPS

Two common Pumcup types: conventional and 45° bevel type . . . available in a complete range of sizes and texture-engineered compositions.



Cutaway view of typical Pumcup installation resulting in prolonged high efficiency.

TAKE it from experienced users, Darcova Pumcups offer payoff advantages that can't be equalled! For example, they last many times as long as ordinary piston packing . . and they *hold peak efficiency* from start to finish. Because of the resulting production and maintenance economies, plant after plant is standardizing on Pumcups.

Improved application of the cup principle does the trick. And Darcova Pumcups are *texture-engineered* in *a range of compositions* to meet most temperature-pressure-fluid conditions. And they are available in sizes and types exactly right for your particular equipment.

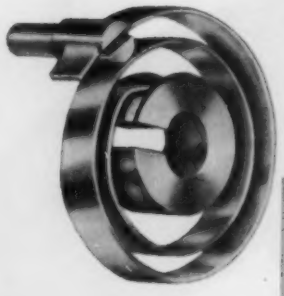
It will pay you to get *all* the facts. Just ask for Pumcup Bulletin No. 5503.

DARLING VALVE & MANUFACTURING CO.
Williamsport 25, Pa.

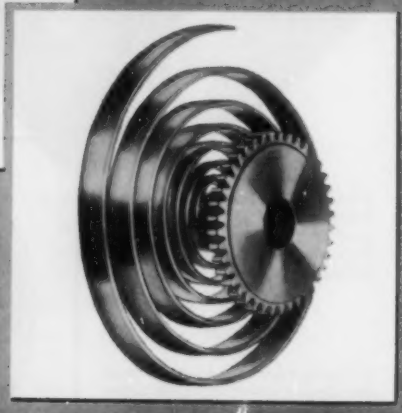
DARCOVA
THE ORIGINAL COMPOSITION CUP
TRADE MARK
PUMCUPS

CHATILLON SPIRAL SPRINGS

. . . better because they're temperature-compensated!



AVAILABLE IN PRACTICALLY ALL SIZES AND CAPACITIES



* Developed by Chatillon with the assistance of Professors A. V. DeForest of Massachusetts Institute of Technology and D. Sayre of Union College.

Chatillon Spiral Springs are unmatched for accuracy, sensitivity and strength . . . for low hysteresis and drift errors.

But what makes these springs unique is their constancy of spring characteristics in extreme temperatures. *Made of Iso-Elastic*, they are virtually unaffected by temperatures ranging from −50°F. to +150°F.*

This kind of spring performance takes know-how. That's why companies like Bendix, Pioneer-Central National Die Casting, etc., specify Iso-Elastic Spiral Springs in their instruments. Chatillon also makes Torsion, Compression and Form Springs in Iso-Elastic and standard alloys.

Have Chatillon's Spring Division show you how easily you may improve the accuracy of your instruments. Write for engineering bulletins.

*U.S.A. Pat. No. 2174171

JOHN CHATILLON & SONS

85 Cliff Street, New York, N.Y.

Manufacturer of Precision Springs and Measuring Apparatus Since 1835

Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 419

Revolving Joints 382
Rheostats 101-102, 256
Rings & Loops..... 259
Rivets 50, 87
Rod Ends 78
Rods
Metallic 343
Rubber ....2nd Cover, 12, 121, 220, 346
Rubber-Bonded-to-Metal 237, 258
Rubber Parts .....2nd Cover, 258, 282 381, 402
Rust Proofing 8, 386

S

Screw Fasteners 387
Screws 38, 58, 71, 225, 268, 275 362, 378, 396
Screw Thread Inserts..... 387
Sealants 302
Seals 55, 85, 98, 237, 263, 273, 296 337, 346, 381, 389, 425
Servomechanism Components 229 390, 404
Sheaves 286-287, 362
Sheets
Metal 240, 321, 403
Plastic 110
Shims 82
Silicone Rubber 49
Silicones 251-252
Silver Alloys 325
Solenoids 297, 378
Specialty Fasteners (Pipe Hangers, Special Cold Headed Parts, etc.).. 66 87, 225, 275, 362, 388, 401
Speed Reducers 47, 128, 266, 279 309, 340
Spinning 295
Springs 336, 404, 420
Sprockets 13, 108, 262, 375, 397
Stampings 108, 261, 295, 340 364, 369, 404
Steel
Alloy ...18-19, 20-21, 51, 100, 113, 239
Carbon 18-19, 100, 113, 239
Coated 22-23, 100, 239
Stainless...10, 22-23, 39, 41, 43, 51, 64 74, 113, 115, 239, 306, 321
Tool 74
Strainers 276, 360
Strip, Plastic 110
Strip, Metallic 70, 93, 113, 239, 240 321, 384

Index of

PRODUCTS ADVERTISED

In This Issue

•

Structural Forms & Shapes.....257, 343
Subcontracting Services 295
Switches.....4, 56-57, 67-68, 101-102 122-126, 264-265, 310, 383, 406

T

Tapes 416
Testing Machines & Equipment..255, 271
Thermistors 409
Thermostats 30, 104, 260, 291, 294
Timers 67-68, 320, 352, 421
Timing Motors 114, 320, 348, 421
Tracing Paper 97
Transformers 104, 122-126, 378
Transistors 380
Transmissions 26-27, 315, 345
Traps (Steam) 276
Tubing
Plastic 110, 330-331, 344
Seamless 51, 327, 343
Welded 22-23, 59, 64, 93, 313, 327

U

Universal Joints 233, 360, 380

V

Valves
Air.....1, 104, 219, 276, 328-329, 335 358-359, 386, 398
Hydraulic 104, 219, 242, 276, 303 305, 335, 386, 398, 404, 406
Vibration Mountings 255
Vibratory Equipment 255, 271

W

Washers 84, 245, 340
Welding
Equipment 277, 285
Nuts 391
Supplies 285
Weldments 257
Wheels 423
Wire 51, 70, 93
Wire & Cable..... 241
Wire Cloth 70, 248, 318
Wire Forming 404

Z

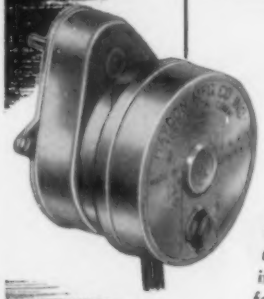
Zinc Coated Strip..... 239

TIME NEVER STATIC

HAYDON*

The designers and engineers at HAYDON know the value of Time and Timing in the development of newer, better products. If the measurement of this never-static, always-vital element is important to your product or process, these men can help you make the most of every minute . . . will work with you to develop the Right Time for your specific needs.

moves ahead on TIME and TIMING!



4400 Series Timing Motor

If, for example, your problem involves 60 cycle, 400 cycle or d-c timing motors, HAYDON can help. Here are a balanced engineering team, an experienced production staff and a plant devoted exclusively to the development and manufacture of timing motors and timing devices. This complete timing service . . . designed to save you time in moving a timing idea through design and development and into practical production . . . is available to you through the nearby, factory-trained HAYDON Field Engineer.

Clip and mail the coupon for his name — and for an informative catalog — today!

HAYDON AT TORRINGTON

HEADQUARTERS FOR TIMING

A SUBSIDIARY OF GENERAL TIME CORP.

*Trade Mark Reg. U. S. Patent Office

HAYDON Manufacturing Company, Inc.
3125 ELM STREET, TORRINGTON, CONN.

☐ Send me the name of the nearby HAYDON Field Engineer.
☐ Send me catalog, "Electric Timing Motors."

NAME_____
POSITION_____
COMPANY_____
CO. ADDRESS_____
CITY_____ ZONE____ STATE_____

Few buyers are as particular about aluminum castings as tire makers. Their tire molds must be extremely accurate, dense, and concentric. Intricate tread designs must be reproduced faithfully.

Morris Bean & Co. recently cast a pair of the world's largest tire molds . . . 9 foot diameter held to ±.060" . . . weight, 2000 lbs. Tire molds, waveguide and fluid flow castings are produced in quantity, using the Antioch Process*. If your design includes aluminum castings with high performance requirements, send us a part print for recommendations.

Morris Bean & Company
Yellow Springs 3, Ohio

*Send for technical booklet about the Antioch Process for aluminum casting.

one-ton precision casting

BEAN

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

Acme Chain Corp. 262
Acme Rubber Manufacturing Co. 289
Acro Switch Div., Acro Mfg. Co. 383
Acushnet Process Co. 258
Allegheny Ludlum Steel Corp. 74
Allen-Bradley Co. 67-68
Allen Mfg. Co. 38
Allied Research Products, Inc. 94
Allis-Chalmers Mfg. Co. 32, 44, 107
Aluminum Co. of America 76-77
American Brass Co. 53
American Chain & Cable Co., Inc. 361
American Chemical Paint Co. 280
American Hard Rubber Co. 282
American Nickeloid Co. 240
American Smelting & Refining Co. 36
American Stock Gear Div., Perfection Gear Co. 340
American Steel & Wire Div., U. S. Steel Corp. 39, 41, 43, 113
Arens Controls, Inc. 402
Armco Steel Corp. 10
Armstrong Cork Co. 79, 416
Arwood Precision Casting Corp. 385
Automatic Electric Sales Corp. 214

Bakelite Co., Div. of Union Carbide & Carbon Corp. 330-331
Baldwin-Lima-Hamilton Corp., Standard Steel Works Div. 259
Barber-Colman Co. 284
Barry Controls, Inc. 255
Bausch and Lomb Optical Co. 250
Bean & Co., Morris 422
Bird & Co., Inc., Richard H. 393
Blood Brothers Machine Div., Rockwell Spring & Axle Co. 233
Bodine Electric Co. 130
Bossert Div., Rockwell Spring & Axle Co. 108
Boston Gear Works 282
Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co. 291
Bristol Co., Socket Screw Div. 378
Brooks & Perkins, Inc. 324
Browning Mfg. Co. 362
Bruning Co., Inc., Charles 35, 69
Buffalo Bolt Co., Div. Buffalo-Eclipse Corp. 401
Bunting Brass & Bronze Co. 253
By-Products Steel Co., Div. of Lukens Steel Co. 100

Calidyne Co. 271
Cambridge Wire Cloth Co. 318
Cameron Iron Works, Inc., Forge & Ordnance Div. 355
Carpenter Steel Co. 93
Carpenter Steel Co., Alloy Tube Div. 64
Central Foundry Div., General Motors Corp. 20-21
Century Electric Co. 301
Chace Co., W. M. 354
Char-Lynn Co. 362
Chatillon & Sons, John 420
Chicago Rawhide Mfg. Co. ..... 2nd Cover
Chicago Screw Co. 396
Chrysler Corp., Industrial Engine Div. 377
Clare & Co., C. P. 65
Clearprint Paper Co. 97
Cleveland Worm & Gear Co. 47
Clipper Belt Lacer Co. 353
Cold Metal Products Co. 239

INDEX TO ADVERTISERS

Columbia-Geneva Steel Div., U. S. Steel Corp. 39, 41, 43
Cone-Drive Gears Div., Michigan Tool Co. 279
Continental Screw Co. 225
Cooper Alloy Foundry Corp. 306
Copperweld Steel Co., Ohio Seamless Tube Div. 327
Cramer Co., Inc., R. W. 320
Crane Packing Co. 337
Crucible Steel Co. of America 115
Cuno Engineering Corp. 112
Curtis Universal Joint Co., Inc. 360

Darling Valve & Mfg. Co. 419
DeLaval Steam Turbine Co. 322
Detroit Coil Co. 297
Dodge Mfg. Corp. 308-309
Doerr Electric Corp. 293
Dormeyer Industries 378
Dow Chemical Co. 105
Dow Corning Corp. 251-252
Dudek & Bock Spring Mfg. Co. 404
DuPont de Nemours & Co., Inc., E. I., Film Department 37
DuPont de Nemours & Co., Inc., E. I., Neoprene 121
DuPont de Nemours & Co., Inc., E. I., Organic Chemicals 372
DuPont de Nemours & Co., Inc., E. I., Plastics 33-34
Durakool, Inc. 310
Durez Plastics Div., Hooker Electrochemical Co. 351
Dynamatic Div., Eaton Mfg. Co. 48

Eastern Air Devices, Inc. 404
Eastern Industries, Inc. 400
Eastman Kodak Co., Industrial Photographic Div. 323
Eclipse Machine Div., Bendix Aviation Corp. 396
Elastic Stop Nut Corp. of America 45
Electric Wheel Co. 423
Elgin National Watch Co., Ordnance Div. 243
Enjay Co., Inc. 220

Fabricon Products, Inc. 349
Fairchild Aircraft Div. 426
Fairfield Mfg. Co. 244
Falk Corp. 117
Federal Mogul Div., Federal-Mogul-Bower Bearing, Inc. 84
Fenwal, Inc. 260
Ferguson Machine & Tool Co. 379
Firestone Plastics Co., Chemical Sales Div., Div. of Firestone Tire & Rubber Co. 40
Flexonics Corp. 314
Foote Bros. Gear & Machine Corp. 81
Foote Gear Works, Inc., Brad 324
Ford Instrument Co., Div. of Sperry-Rand Corp. 334
Formsprag Co. 428
Frenchtown Porcelain Co. 374
Friez Instruments Div., Bendix Aviation Corp. 409

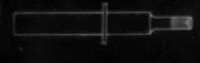
Galland-Henning, Nopak Div. 398
Garlock Packing Co. 296
Garrett Co., Inc., George K. 340
Gates Rubber Co. 254
Gear Specialties, Inc. 11
General Controls Co. 104

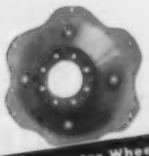
(Continued on Pg. 424)

ELECTRIC

Wheels Engineered for the Job

WRITE US FOR RECOMMENDATIONS




Rear Tractor Wheel for Demountable Rim

Planter Press Wheel—one piece rim with or without rubber tire

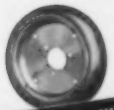
Rear Tractor Wheel Reversible

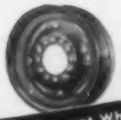
Pick-up Wheel Crown-face Steel Rim

Garden Tractor Wheel Reversible

Combine Wheel Reversible

Spreader Wheel


Press and Gage Wheel Rubber Tire

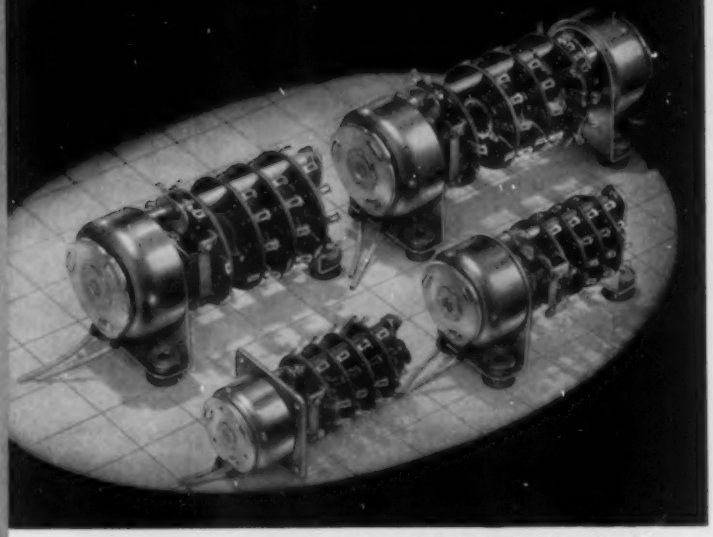

SAE Implement Wheel Reversible

ELECTRIC WHEEL COMPANY

2805 SPRUCE · QUINCY, ILLINOIS

LEDEX SELECTING and STEPPING RELAYS

WILL HELP YOU SIMPLIFY REMOTE SELECTION of CIRCUITS!



A few examples of standard Model, Ledex relays. Use the 1" squares in the background to estimate size of the relays.

Ledex Relays are available to perform a variety of switching jobs... STEPPING...COUNTING...ADDING AND/OR SUBTRACTING...PROGRAMING... CIRCUIT SELECTING...and HOMING.

SEND US, ON YOUR LETTERHEAD, THE DETAILS OF YOUR SWITCHING REQUIREMENTS AND LET LEDEX ENGINEERS WORK WITH YOU TO DETERMINE IF LEDEX RELAYS ARE THE ANSWER.

G. H. Leland INC.

123 WEBSTER STREET, DAYTON 2, OHIO

IN CANADA. MARSLAND ENGINEERING LTD., KITCHENER, ONTARIO

INDEX TO ADVERTISERS

(Continued from Pg. 423)

General Electric Co., Apparatus Dept. 28-29, 122-126
General Electric Co., Chemical Div. (Silicone) 49
General Industries Co. 357
General Plate Div., Metals & Controls Corp. 31
Gering Products, Inc., Extruded Products Div. 344
Gerotor May Corp. 315, 345
Gits Bros. Mfg. Co. 263
Gleason Works 6
Goodrich Co., B. F. 87
Gries Reproducer Corp. 292
Grip Nut Co. 374

Handy & Harman 325
Hanna Engineering Works 283
Hannifin Corp. 311
Hansen Mfg. Co., Inc. 114
Harrington & King Perforating Co. 403
Hartford Steel Ball Co. 378
Harvey Aluminum Sales, Inc. 343
Haydon Co., A. W. 348
Haydon Mfg. Co., Inc. 421
Haynes Stellite Co., Div. of Union Carbide & Carbon Corp. 60
Heim Co. 78
Helicoid Gage Div., American Chain & Cable Co., Inc. 361
Heli-Coil Corp. 387
Hilliard Corp. 290
Hitemp Wires, Inc. 241
Holo-Krome Screw Corp. 268
Hughes Research & Development Laboratories 417
Hunter Douglas Corp. 272
Hunter Spring Co. 336

Illinois Gear & Machine Co. 75
International Harvester Co., Industrial Power Div. 111
International Nickel Co., Inc. 46, 86
International Packings Corp., Sub. of Graton & Knight Co. 237
International Rectifier Corp. 352

Johnson Bronze Co. 376
Johnson Corp. 382
Johns-Manville Corp. 98
Johnson Machine Co., Carlyle 299
Jones & Laughlin Steel Corp. 313

Kaiser Aluminum & Chemical Corp. 24-25, 83, 332-333
Kaydon Engineering Corp. 227
Keystone Carbon Co. 89
Kilian Mfg. Corp. 374
Koppers Co., Inc., Chemical Div. 307
Kraissl Co., Inc. 360
Kurz-Kasch Co. 399

L. O. F. Glass Fibers Co. 312
Lamb Electric Co. 317
Laminated Shim Co., Inc. 82
LaSalle Steel Co. 18-19
Leiman Brothers, Inc. 382
Leland, Inc., G. H. 424
Librascope, Inc. 390
Linde Air Products Co., Div. of Union Carbide & Carbon Corp. 285
Linear, Inc. 55
Link-Belt Co. 13, 61
Logansport Machine Co., Inc. 335

INDEX TO ADVERTISERS

Lovejoy Flexible Coupling Co..... 380
Lukens Steel Co., By-Products Steel Div. 100

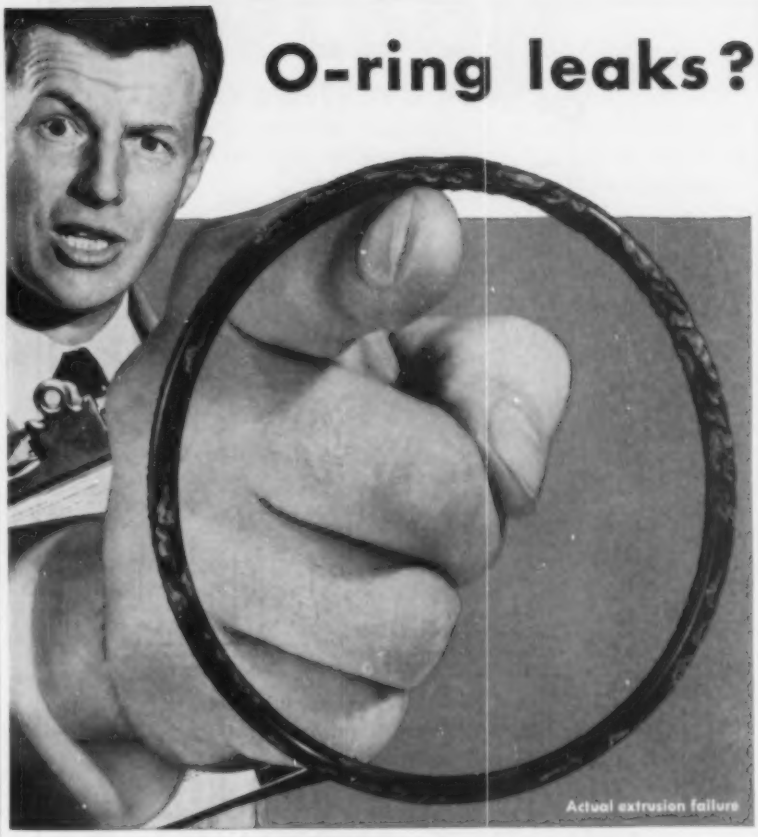
McGill Mfg. Co., Inc..... 235
McGraw-Hill Book Co., Inc..... 403
McLouth Steel Corp..... 321
Madison-Kipp Corp. 267
Magnatrol Valve Corp..... 404
Magnesium Co. of America..... 350
Magnetic Amplifiers, Inc..... 370
Mahon Co., R. C..... 257
Mallory & Co., Inc., P. R.....4, 80
Marbon Chemical Div., Borg-Warner Corp. 15
Marsh Instrument Co..... 386
Massachusetts Gear & Tool Co..... 390
Master Electric Co.....3rd Cover
Matthews & Co., Inc., Jas. H..... 350
Mayline Co. 402
Mechanical Air Controls, Inc.....358-359
Metals & Controls Corp., General Plate Div. 31
Metals & Controls Corp., Spencer Thermostat Div. 30
Meyercord Co. 388
Michigan Tool Co., Cone Drive Gears Div. 279
Micro-Switch Div., Minneapolis-Honeywell Regulator Co.....264-265
Midland Steel Products Co..... 391
Miehle-Dexter Supercharger Div. Dexter Folder Co..... 363
Miller Fluid Power Co.....90-91
Miniature Precision Bearings, Inc.... 106
Minneapolis Honeywell Regulator Co., Industrial Div. 294
Minnesota Mining & Mfg. Co..... 103
Minnesota Rubber & Gasket Co..... 381
Moraine Products Div., General Motors Corp. 116
Mosinee Paper Mills Co..... 88
Morse Chain Co..... 373
Mueller Brass Co.....246-247

National Lock Washer Co..... 42
National Machine Products Co..... 388
National Motor Bearing Co., Inc..... 85
National Pneumatic Co., Inc., Industrial Actuators & Controls Div..... 367
National-Standard Co. 70
National Tube Div., U. S. Steel Corp. 39, 41, 43
Newark Wire Cloth Co..... 248
New Departure Div., General Motors Corp. 134
New York Air Brake Co..... 369
New York Belting & Packing Co., Gilmer Timing Belt Div..... 118
Nicholson & Co., W. H..... 276
Norgren Co., C. A.....328-329
Northrop Aircraft, Inc..... 410

Ohio Seamless Tube Div., Copperweld Steel Co. 327
Ohmite Mfg. Co.....101-102
Ortman-Miller Machine Co..... 333

Packard Electric Div., General Motors Corp. 16
Palnut Co. 382
Parker Appliance Co..... 425
Parker-Kalon Div., General American Transportation Corp. 71

(Continued on Pg. 426)



O-ring leaks?

. . . then call in your Parker field engineer for help

Having trouble with O-ring failures? Nibbled, worn, battered, leaking like a sieve? Whether your problem is in the basic design or compound, it's time to call a Parker representative.

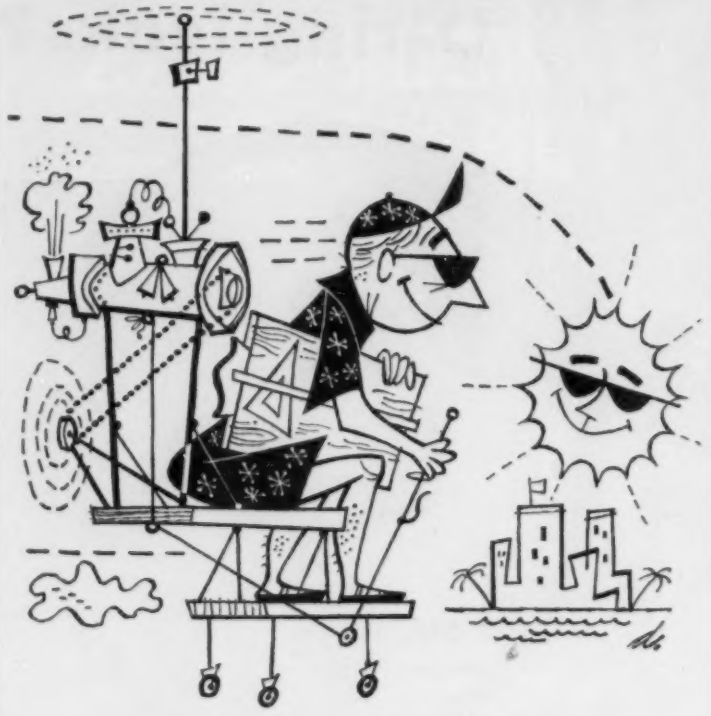
Parker field engineers are trained trouble shooters. There is one in your area. From Parker you can get exactly the *right* O-ring and gland design for your *specific* application.

Compare Parker O-rings with any other make. You'll find that Parker O-rings are precision-molded of superior compounds. They have been developed as the result of years of experimentation to provide the proper elongation, tensile strength, compression set ratings, resistance to oils, fuels, chemicals, and high and low temperatures. Laboratory and service tests make sure that all rated characteristics are held.

Call your Parker representative for assistance. Write for new Bulletin 5712B2 on "New Hydraulic Fluids and Seals".

RUBBER PRODUCTS DIVISION
Section 516-L
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio
1538 So. Eastern Ave., Los Angeles, Cal.

Parker
Hydraulic and fluid system components



FOLLOW THE SUN TO A NEW ENGINEERING OPPORTUNITY!

Get new enjoyment and satisfaction from your work in sunny, attractive Florida!

Fairchild's new engineering facilities at St. Augustine combine two important attractions: Advanced research and development in all phases of aviation, and superb living conditions in one of America's most delightful areas.

Openings exist for engineers who have experience, ambition and talent to contribute to the Fairchild Research and Development programs in such fields as aerodynamics, structures, weights and design.

Investigate this opportunity for a sunny, profitable future! Send your resume today to Walter Tydon, Chief Engineer.

A Division of
Fairchild Engine and Airplane Corporation

FAIRCHILD

AIRCRAFT DIVISION • HAGERSTOWN, MARYLAND

...WHERE THE FUTURE IS MEASURED IN LIGHT-YEARS

INDEX TO ADVERTISERS

(Continued from Pg. 425)

Parker Rust Proof Co. 8
Parker Stamp Works, Inc. 415
Pass & Seymour, Inc. 406
Peerless Electric Co., Fan & Blower Div. 392
Peerless Electric Co., Motor Div. 384
Penn Metal Co., Inc. 274
Perfection Gear Co., American Stock Gear Div. 340
Perkins Machine & Gear Co. 375
Pesco Products Div., Borg Warner Corp. 269
Philadelphia Gear Works, Inc. 128, 306
Polymer Corp. of Pennsylvania 110
Polytechnic Research & Development Co., Inc. 380
Potter & Brumfield Mfg. Co., Subs. American Machine & Foundry Co. 365
Pratt & Whitney 418
Precision Castings Co., Inc., Subs. of Harrisburg Steel Corp. 96
Precision Extrusions 366
Precision Rubber Products Corp. 273
Prestite Engineering Co. 302
Production Instrument Co. 389
Progressive Mfg. Co. 362
Protective Closures Co., Inc. 95
Purolator Products, Inc. 395

Racine Hydraulics & Machinery Corp. 303
Ramsey Corp. 392
Reeves Pulley Co., Div. of Reliance Electric & Engrg. Co. 26-27
Republic Mfg. Co. 406
Republic Steel Corp. 22-23
Resistoflex Corp. 407
Revere Copper & Brass, Inc. 2
Rhodes Inc., M. H. 352
Rochester Products Div., General Motors Corp. 59
Rockford Clutch Div., Borg-Warner Corp. 14
Rockwood Sprinkler Corp. (Ball Valve Div.) 242
Roper Corp., Geo. D. 405
Ross Operating Valve Co. 1
Rubatex Div., Great American Industries, Inc. 346

SKF Industries, Inc. 288
Sandusky Foundry & Machine Co. 371
Sciaky Brothers, Inc. 277
Scintilla Div., Bendix Aviation Corp. 350
Sculp-Metal Co. 398
Shakeproof Div., of Illinois Tool Works 245
Shenango Penn Mold Co. 319
Sier-Bath Gear & Pump Co., Inc., Gear Div. 400
Simmons Fastener Corp. 66
Solar Aircraft Co. 342
South Chester Corp., Southco Div. 50
Southern States Iron Roofing Co. 384
Sparta Manufacturing Co. 394
Spencer Thermostat Div., Metals & Controls Corp. 30
Spincraft, Inc. 295
Sprayiat Corp. 249
Square D Co. 56-57
Stalwart Rubber Co. 402
Standard Pressed Steel Co. 58, 120
Stokes Machine Co., F. J. 300

Taylor Fiber Co. 356
Tennessee Coal & Iron Div., U. S. Steel Corp. 39, 41, 43
Thermoid Co. 341
Thomas Flexible Coupling Co. 326

INDEX TO ADVERTISERS

Tickle Engineering Works, Inc., Arthur 386
Timken-Detroit Brake Co., Rockwell Spring & Axle Co..... 304
Timken Roller Bearing Co. (Industrial) .....4th Cover
Timken Roller Bearing Co., Steel & Tube Div..... 51
Tinnerman Products Inc..... 132
Tomkins-Johnson Co..... 278
Torrington Co., Needle Bearing Div... 54
Torrington Co., Specialties Div..... 127
Townsend Co..... 275
Transicoil Corp..... 229
Transue & Williams Steel Forging Corp. 261

Union Carbide & Carbon Corp.
Bakelite Co. 330-331
Haynes Stellite Co..... 60
Linde Air Products Co..... 285
U. S. Axle Co., Inc..... 316
U. S. Electrical Motors Inc..... 92
U. S. Gasket Co..... 298
U. S. Graphite Co.....62-63
U. S. Radium Corp..... 393
U. S. Rubber Co.....12, 52
U. S. Steel Corp.....39, 41, 43
U. S. Steel Export Co.....39, 41, 43
U. S. Steel Supply Div., U. S. Steel Corp. 39, 41, 43
Universal Clay Products Co..... 396
Universal Oil Seal Co..... 389

Vard, Inc. 338-339
Veeder-Root Inc..... 17
Versa Products Co., Inc..... 219
Vickers, Inc., Div. of Sperry-Rand Corp. 305
Viking Pump Co..... 348
Virginia Gear & Machine Corp...128, 306
Vulcan Electric Co..... 388

Wagner Electric Corp..... 270
Waldes-Kohinoor, Inc..... 99
Wales-Strippit Corp..... 347
Ward Leonard Electric Co..... 256
Watlow Electric Mfg. Co..... 310
Webster Electric Co., Oil Hydraulics Div. 119
Weldon Tool Co.....† 427
Western Gear Works..... 109
West Point Manufacturing Co..... 392
White Dental Mfg. Co., S. S..... 231
Whitney Chain Co..... 397
Wiegand Co., Edwin L., Ind. Div..... 359
Winsmith, Inc..... 266
Wisconsin Motor Corp..... 386
Worcester Pressed Steel Co..... 364
Worthington Corp., Multi-V Drive 286-287
Worthington Corp., Pump & Compressors Div.....72-73
Wyman-Gordon Co..... 368

■

PROFESSIONAL SERVICES..... 411

Classified Advertising
F. J. Eberle, Ass't. Mgr.

EMPLOYMENT OPPORTUNITIES..411-414
SPECIAL SERVICES
Contract Work..... 411
EQUIPMENT
(Used or Surplus New)
For Sale 411

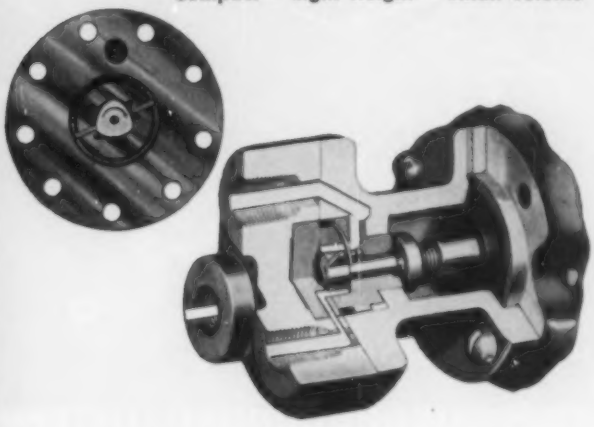
Index to Advertisers begins on P 422
Products Index begins on P 415

WELDON

FLUID METERING PUMPS

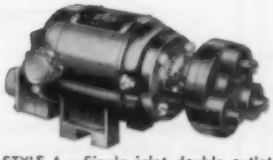
Positive Displacement Rotor Type. For Industrial Applications, Aircraft Anti-Icing and Aircraft Fuel.

Compact • Light Weight • Small Volume

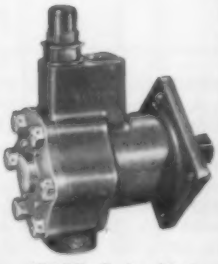


IT'S SO SIMPLE!

The rotation of the rotor draws the fluid in through two passages, filling the cavities formed by the three lobes of the rotor. This fluid is sealed within these small cavities until it is forced through the two outlet holes by the floating blades. The flow may be kept uniformly divided through two outlet ports, or may be combined internally for passage through a single port.



STYLE A—Single inlet double outlet type aircraft pump



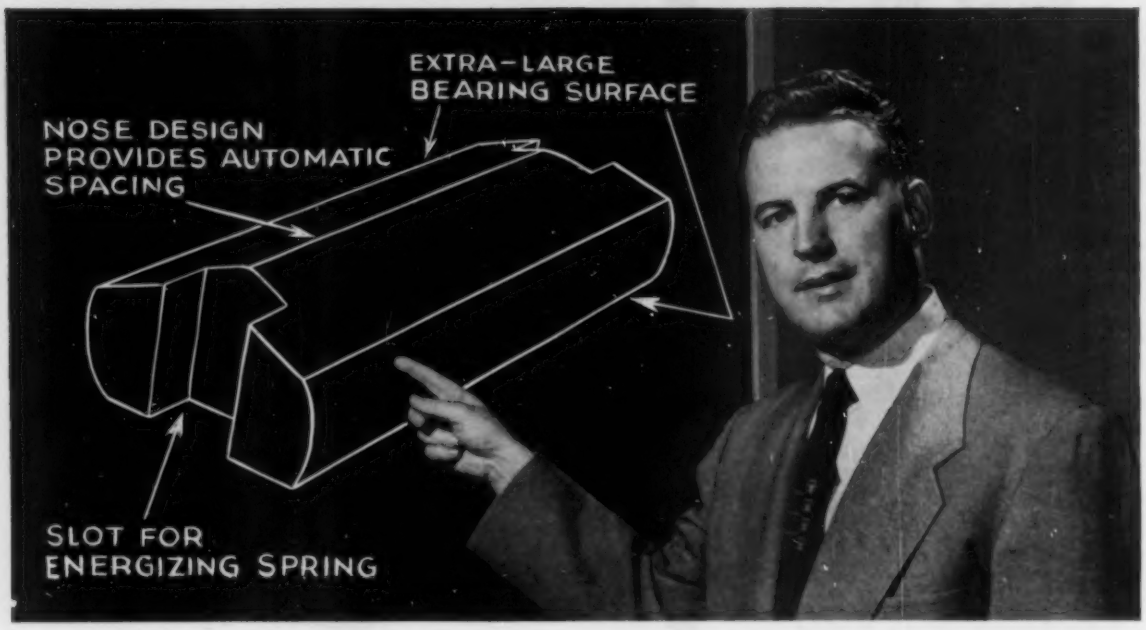
STYLE F—Engine driven fuel pump

STYLE C—Industrial pump

Send for Weldon Manual and Catalog with detailed specifications and installation drawings.

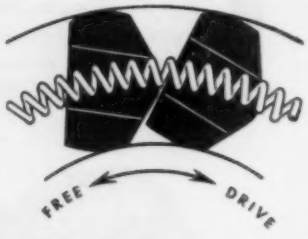
THE WELDON TOOL COMPANY

3000 WOODHILL ROAD · · · CLEVELAND 4, OHIO

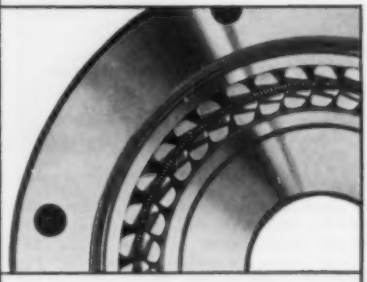


Here's why the unique design of this sprag gives you maximum clutch precision

A simple illustration of how a sprag works: A boy dragging a stick behind him finds no resistance to his efforts. However, when he pushes the stick ahead of him at a high angle—it sticks and knocks the wind out of him. The boy's body represents an outer race — the ground; an inner race. The stick represents a sprag wedged between the two races.



Sprags used in Formsprag Clutches are highly developed, precision wedges of hardened alloy steel. Due to the sprag's design, an unusually high amount of torque is delivered from one concentric race to the other. When torque is applied, the sprags are instantaneously engaged. When torque is removed, the sprags release instantaneously.



Basic construction of the Formsprag Clutch is simple. A full complement of sprags is inserted between inner and outer concentric races. Contact with both race surfaces is maintained by energizing springs. Formsprag construction allows more sprags to be inserted in a smaller area than other clutch designs. Result: greater torque capacity in a smaller clutch.

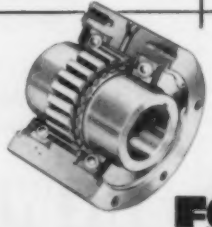
Whatever your clutch application—over-running, backstopping, or indexing—Formsprag Clutches offer you these distinct advantages:

- Higher Torque Capacity
- Longer Life
- Internal Simplicity
- No Measurable Backlash
- Exceptionally Low Maintenance

The experienced Formsprag Engineering Staff is available to recommend a standard clutch or to design one for your specific application.

Why not write for details today.

A6-18



OVER-RUNNING—
BACKSTOPPING—
INDEXING

FORMSPRAG *Clutches*

Distributors in Principal Cities

23607 Hoover Road, Van Dyke, Michigan.

World's Largest Exclusive Manufacturers of Over-running Clutches

NEW 3-POINT EASY-TO-USE

READER SERVICE TO HELP YOU

. . . find out more about the New Materials and Components described

. . . obtain copies of new catalog and bulletins

. . . get more information about products advertised in this issue

Now, one of these handy prepaid postcards will bring you more information about any product advertised or mentioned editorially in this issue of *Product Engineering*.

Here's How to Use the Card

For your copy of any new catalog or bulletin, circle key number in the space indicated. Bulletins are described on pages 309 to 325.

To get more data about new Components, Materials and Parts fully described on pages 222 to 306; just circle the appropriate key number.

To get more information about advertised products, circle the page number of the advertisement in which you are interested. If more than one advertisement is located on a single page, letters preceding number identify each advertisement. Key: T—Top; B—Bottom; R—Right; L—Left; TL—Top Left; BL—Bottom left; TR—Top right; BR—Bottom right.

For specialized data . . . prices, sizes available, nearest source of supply, etc. . . . do not circle key number but indicate your needs in the space alloted at the bottom of the card. Use this space, too, if information about a specific product among several mentioned in an advertisement is desired.

PRINT or TYPE your address before mailing

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—4¢ POSTAGE WILL BE PAID BY—

PRODUCT ENGINEERING
READER SERVICE DEPARTMENT
330 WEST 42nd ST.
NEW YORK 36, N. Y.

PLEASE TYPE OR PRINT

Name _____

Position _____

Company _____

Address _____

City & State _____

1-56

NEW PRODUCTS... Description of these new engineering materials appear on pages 222 to 306. Circle key number for more data

1—Adjustable Electronic Motor Drive
2—Speed-change Sensing System
3—Steel Nuts For Up To 800 F
4—Battery for Up to 20 Years
5—Twelve-Position Rotary Switch
6—Insert Requires No Tapping
7—Voltage-Sensing Rectifiers
8—Wick Lubricates Spring
9—Miniature Gearing
10—Miniature Sampling Switch
11—Self-Adjusting Air Filter
12—Fitting for Liquidtight Conduit
13—Time-Delay Relay
14—Clutches for Heavy Duty Equipment
15—Bronze Solder End Valves
16—Totally Enclosed Fhp Motors
17—Centrifugal Blower
18—Small Relay for Heavy Current
19—Adjustable Electronic Timer
20—Rotary Table Has Indexing
21—Miniature Linear Transducer
22—Deposited Carbon Resistors
23—Three-Way Solenoid Valve
24—Shaded Pole, Fhp Motor
25—Low-Level, High Speed Switch
26—Centrifugal Pump
27—Subminiature Selenium Diodes
28—Photoelectric Counter
29—Snap-Action Thermostat
30—Electrolytic Capacitors
31—Germanium Power Diodes
32—Miniature Differential
33—High Speed Switches
34—Electro-Magnetic Clutches
35—Four-Throw Toggle Switch
36—Pneumatic Regulators
37—Miniature Connectors
38—Explosionproof Conduiets
39—Packaged D-c Power Packs
40—Disconnect for Fuel, Oil Lines
41—Time Delay Relat For Use at 125 C
42—Push-Pull Magnetic Amplifier
43—Subminiature Toggle Switch
44—Flow Indicator Stops Backflow
45—Custom and Standard Springs
46—Rectifier Operates at Up to 200 C
47—Power Supply With Transformer
48—Miniaturized Servo Motor
49—Tubular Selenium Rectifiers
50—Germanium Transistors
51—All-Purpose Relays
52—Spool-Type Three-Way Valve-Pump
53—Subminiature Blower
54—Subminiature Connector
55—A-c Voltage Divider

PRINT or TYPE your address on other side before mailing

CIRCLE THESE NUMBERS FOR FURTHER INFORMATION ON PRODUCTS ADVERTISED

C2	1	2	4	6	8	10	11	12	13	14	15	16	17
18-9	20-1	24-5	26-7	28-9	30	31	32	33-4	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49	50	51	52	53
54	55	56-7	58	59	60	61	62-3	64	65	66	67-8	69	70
71	72-3	74	75	76-7	78	79	80	81	82	83	84	85	86
87	89	89	90-1	92	93	94	95	96	97	98	99	100	101-2
103	104	105	106	107	108	109	110	111	112	113	114	115	116
117	118	119	120	121	122-3	124-5	126	127	128	130	132	134	214
219	220	225	227	229	231	233	235	237	239	240	241	242	243
244	245	246-7	248	L249	R249	250	251-2	253	254	255	256	257	258
259	260	261	262	263	264-5	266	267	268	269	270	271	272	273
274	275	276	277	278	279	280	281	282	283	284	285	286-7	288
289	290	291	292	293	294	295	296	297	298	299	300	301	302
303	304	305	L306	R306	307	308	309	T310	B310	311	312	313	314
315	316	317	318	319	320	321	323	T324	B324	325	326	327	328
329	330-1	332	L333	R333	334	335	336	337	338-9	L340	R340	341	342
343	344	345	346	347	T348	B348	349	T350	BL350	BR350	351	T352	B352
353	354	355	356	357	358	L359	R359	L360	R360	361	L362	TR362	BR362
363	364	365	366	367	368	369	370	371	372	373	T374	BL374	BR374
375	376	377	L378	TR378	BR378	379	L380	R380	381	L382	TR382	BR382	383
L384	R384	385	L386	TR386	BR386	387	L388	TR388	BR388	L389	R389	T390	B390
391	L392	TR392	BR392	T393	B393	394	395	L396	TR396	BR396	397	TL398	BL398
399	L400	TR400	401	L402	TR402	BR402	L403	R403	L404	TR404	BR404	405	L406
TR406	407	409	415	416	419	420	421	422	423	424	425	427	428
C3	C4												

CIRCLE THESE NUMBERS FOR INFORMATION ON NEW PRODUCTS LISTED IN THIS ISSUE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88										

CIRCLE THESE NUMBERS FOR COPIES OF NEW BULLETINS LISTED IN THIS ISSUE

89	90	91	92	93	94	95	96	97	98	99	100	101	102
103	104	105	106	107	108	109	110	111	112	113	114	115	116
117	118	119	120	121	122	123	124	125	126	127	128	129	130
131	132	133	134	135	136	137	138	139	140	141	142	143	144
145	146	147	148	149	150	151	152	153	154	155	156	157	158

Card expires March 1

CIRCLE THESE KEY NUMBERS FOR FURTHER DATA ON.....

CIRCLE THESE KEY NUMBERS FOR INFORMATION ABOUT.....

CIRCLE THESE KEY NUMBERS FOR YOUR COPIES OF.....

USE THIS SPACE TO INDICATE REQUIRED.....

56—Subminiature Relay
57—Rubber Sheet Packing
58—Worm-Drive Capacitor
59—Air and Hydraulic Valves
60—Sun Battery Cells
61—Cool-Running A-c Relay
62—Back-Ups for O-Rings
63—Four-Way Solenoid Selector Valves
64—Explosionproof Geared Motor
65—Carbon Film Resistor
66—Standard Air-Hydraulic Cylinders
67—Flanged Bearing Liners
68—Paste Solder Contains Own Flux
69—Totally Enclosed Motor
70—Resistors for Printed Circuits
71—Hose Assembly for —100 F to 500 F
72—Fatigue-Resistant Steel Bar
73—Servo Control Valves
74—Fast-Drying Enamels
75—Variable Speed Pulley
76—Air Cylinders
77—Regulated Power Supplies
78—Electronic Counting System
79—Heating Elements 0.032 in. Thick
80—Rotary Switch for Small Appliances
81—Pneumatic Switching Valve
82—Hydraulic Symbols Template
83—A-c Line Regulator
84—Metalized Hermetic Terminals
85—Drafting Desk
86—Oscillograph Record Camera
87—Self-Measuring Dividers
88—Drawing Board T-Square Combination

NEW BULLETINS . . . listed below are described on pages 309 to 325. Circle key number for your copy.

89—Electrical-Electronic Components
90—Double-Enveloping Gears
91—Speed Control
92—Deposited Carbon Resistors
93—Powder Metallurgy Standards
94—Cast Irons
95—Stainless Brazing Paste
96—Asbestos and Other Products
97—Speed Control and Drive
98—Alloy for Anchoring Components
99—Brass Alloy Powders
100—Bismuth Alloys
101—Carbon and Alloy Steels
102—Metallizing
103—Seamless and Welded Tubing
104—Investment Casting
105—Colloidal Dispersions
106—Fluid Motors
107—Glass-bonded Mica
108—Electric Motors
109—Selenium Rectifiers
110—Hydraulic Tube Fittings
111—Clad Metals
112—Relays
113—Magnetic Materials
114—Interval Timer
115—Steel Industry Statistics
116—PVC Pipe Fittings and Flanges
117—Ruling and Drawing Devices
118—Piston Packing
119—Heat
120—Cold-Finished Steel Bars
121—Forgings
122—Powder Metallurgy
123—Aluminum Bronze Alloys
124—Vibration Mountings

PRINT or TYPE your address on other side before mailing

PRODUCTS ADVERTISED

CIRCLE THESE NUMBERS FOR FURTHER INFORMATION ON PRODUCTS ADVERTISED

C2	1	2	4	6	8	10	11	12	13	14	15	16	17
18-9	20-1	24-5	26-7	28-9	30	31	32	33-4	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49	50	51	52	53
54	55	56-7	58	59	60	61	62-3	64	65	66	67-8	69	70
71	72-3	74	75	76-7	78	79	80	81	82	83	84	85	86
87	88	89	90-1	92	93	94	95	96	97	98	99	100	101-2
103	104	105	106	107	108	109	110	111	112	113	114	115	116
117	118	119	120	121	122-3	124-5	126	127	128	130	132	134	214
219	220	225	227	229	231	233	235	237	239	240	241	242	243
244	245	246-7	248	L240	R240	250	251-2	253	254	255	256	257	258
259	260	261	262	263	264-5	266	267	268	269	270	271	272	273
274	275	276	277	278	279	280	281	282	283	284	285	286-7	288
289	290	291	292	293	294	295	296	297	298	299	300	301	302
303	304	305	L306	R306	307	308	309	T310	B310	311	312	313	314
315	316	317	318	319	320	321	323	T324	B324	325	326	327	328
329	330-1	332	L333	R333	334	335	336	337	338-9	L340	R340	341	342
343	344	345	346	347	T348	B348	349	T350	BL350	BR350	351	T352	B352
353	354	355	356	357	358	L359	R359	L360	R360	361	L362	TR362	BR362
363	364	365	366	367	368	369	370	371	372	373	T374	BL374	BR374
375	376	377	L378	TR378	BR378	379	L380	R380	381	L382	TR382	BR382	383
L384	R384	385	L383	TR386	BR386	387	L388	TR388	BR388	L389	R389	T390	B390
391	L392	TR392	BR392	T393	B393	394	395	L396	TR396	BR396	397	TL398	BL398
399	L400	TR400	401	L402	TR402	BR402	L403	R403	L404	TR404	BR404	405	L406
TR406	407	409	415	416	419	420	421	422	423	424	425	427	428
C3	C4												

NEW PRODUCTS . . .

CIRCLE THESE NUMBERS FOR INFORMATION ON NEW PRODUCTS LISTED IN THIS ISSUE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88										

NEW BULLETINS . . .

CIRCLE THESE NUMBERS FOR COPIES OF NEW BULLETINS LISTED IN THIS ISSUE

89	90	91	92	93	94	95	96	97	98	99	100	101	102
103	104	105	106	107	108	109	110	111	112	113	114	115	116
117	118	119	120	121	122	123	124	125	126	127	128	129	130
131	132	133	134	135	136	137	138	139	140	141	142	143	144
145	146	147	148	149	150	151	152	153	154	155	156	157	158

SPECIFIC DATA . . .

Card expires March 1

125—Counters and Actuators
126—Magnetic Clutches and Brakes
127—Beryllium Products
128—Hard-Surfacing
129—Indicator Lights
130—Expansion Joints
131—Rigid PVC Pipe
132—Control Transformers
133—Stainless Fasteners
134—Sound
135—Hydraulic Equipment
136—Hydraulic Equipment
137—Numerical Indicator
138—Rotary Stepping Switches
139—Relays
140—Relays
141—Pressure Ratio Indicator
142—Fhp Motors
143—Limit Switch
144—One-Way Impulse Switch
145—Electrical Connectors
146—Two-Hand Clutch Controls
147—Potentiometers
148—Analog-to-Digital Converter
149—Electro-Mechanical Integrator
150—Lattice Mountings
151—Counters
152—Mechanical Tubing
153—PVC Pipe and Fittings
154—Steel Reels
155—Venturi Tubes and Nozzles
156—Hose Couplings
157—Speed Control
158—Machine Tool Clutches

USE THIS SERVICE

. . . . to get your copies of new catalogs and Bulletins

. . . . for information on New Products listed in this issue

. . . . for more information about products advertised in this issue

PRINT or TYPE your address before mailing

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—4¢ POSTAGE WILL BE PAID BY—

PRODUCT ENGINEERING
READER SERVICE DEPARTMENT
330 WEST 42nd ST.
NEW YORK 36, N. Y.

PLEASE TYPE OR PRINT

Name _____

Position _____

Company _____

Address _____

City & State _____ 1-56

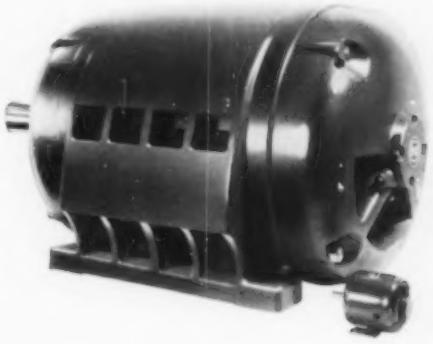
Requests for information made through *Product Engineering* Reader's Service will be forwarded to the manufacturer as quickly as we can process them. If you write directly to the manufacturer, please identify advertisement by issue and page number to facilitate reply.

You Name It—Thousands of Ratings

From 1/8 to 400 H. P.

See MASTER for a selection of motor drives that you can get nowhere else—for specialized power drives unequalled for flexibility, compactness and performance. See Master for the right horsepower, right shaft speed, right mounting features—to add salability to your products, efficiency to your plant equipment.

Master components are designed to combine in one compact unit to suit your needs exactly—all the way up to 400 H. P. Just ask us for information.



Motor Ratings	⅛ to 400 H.P. All phases, voltages, and frequencies.
Motor Types	Squirrel cage, slip ring, synchronous, repulsion-start induction, capacitor, direct current.
Construction	Open, enclosed, splash-proof, fan-cooled, explosion-proof, special purpose.
Speeds	Single-speed, multi-speed, and variable speed.
Installation	Horizontal or vertical, with or without flanges and other features.
Power Drive Features	Electric brakes (2 types)—5 types of gear reduction up to 432 to 1 ratio. Mechanical and electronic variable speed units—fluid drives—every type of mounting.

THE MASTER ELECTRIC COMPANY
Dayton 1, Ohio

MASTER ELECTRIC MOTORS

How high load capacity is built into less space in Dodge-TIMKEN All-Steel pillow block

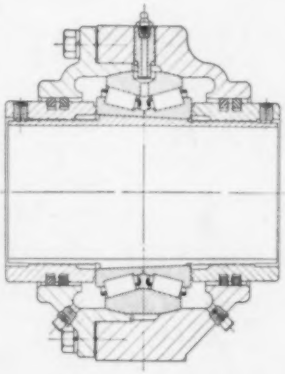
THIS rugged Dodge-Timken pillow block packs more capacity in less space than ever before. All-steel construction gives it extra strength and durability. The design is compact. No special thrust devices that take up extra space are needed—the two-row Timken® tapered roller bearing takes *both* radial and thrust loads in any combination. And full line contact between the rollers and races assures high load capacity.

The cutaway view below shows the bearing. It is of special design, with tapered bore and self-aligning spherical outer surface—never requires adjustment. As in all Timken bearings, races and rollers are case-carburized and have tough, shock-resistant cores under hard, wear-resistant surfaces. Under normal conditions, the Timken bearing will last the life of the machinery with which the pillow block is used.

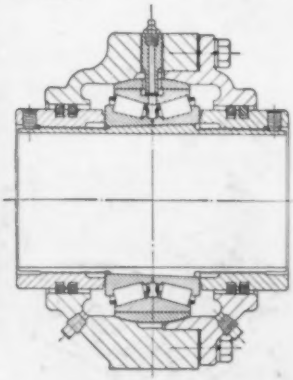
In addition to the all-steel pillow block shown here, Timken bearings are also used in the Type "E", Double-Interlock, Type "C", and Special-Duty pillow blocks—other versatile pillow blocks in the Dodge-Timken line with a wide variety of uses in industry.

To be sure of the finest bearing steel, we make our own—America's only bearing manufacturer that does. No other bearings can give you all the advantages you get with Timken bearings. Include them in your design plans... specify them for the machines you buy or build. Look for the trademark "Timken"—it's on the bearing that makes any machine run better. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable: "TIMROSCO".

This symbol on a product means its bearings are the best.



How **DODGE MANUFACTURING CORPORATION,** Mishawaka, Ind., mounts Timken bearings in the Dodge-Timken All-Steel pillow block. Above: non-expansion block with fixed bearing. Below: expansion block with floating bearing.



TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◐ AND THRUST ◐ LOADS OR ANY COMBINATION ✳